SOLDERING AND BRAZING

HOBART

SOFT SOLDERING, HARD SOLDERING AND BRAZING

A PRACTICAL TREATISE ON TOOLS, MATERIAL AND OPERATIONS; FOR THE USE OF METAL WORKERS, PLUMBERS, TINNERS, MECHANICS AND MANUFACTURERS : : : :

BY

JAMES F. HOBART, M. E.

WITH 62 ILLUSTRATIONS REPRODUCED FROM ORIGINAL DRAWINGS

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PREFACE.

The operations of soldering and brazing are suggestive to some as being comparatively simple of execution, requiring no special degree of skill or experience on the part of the workman. As a matter of fact they involve a wide range of manipulation and frequently demand experienced workmanship of a high order.

At the same time so many mechanics are accustomed to perform soldering operations with poorly prepared tools and with appliances which might be greatly improved upon, that the author is led to offer this book in the hope that it will serve as a practical aid to improved methods, thereby serving the interests of mechanics who seek advancement as well as employers who are alert to the importance of efficiency and economy in the methods pursued in their establishments.

Therefore the author has dwelt with considerable fullness upon the many phases of soldering and brazing, giving the results of experience and observation acquired through long practice and experiment in these channels.

If the result is accomplished, of assisting operators to a larger appreciation of the requirements of expert workmanship in these really important branches of mechanics, he shall consider that the time and labor spent in preparing the treatise has been well applied.

James F. Hobart.

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SOLDERING AND BRAZING.

CHAPTER I.

SOLDERING TOOLS.

Introductory and Explanatory.

Soldering is a very peculiar, although very common, operation, whereby two metals, either similar or dissimilar, are united by a third metal by means of heat. Soldering, to quote from an ancient dictionary by Webster, is to unite with metallic cement. A more modern issue of Webster's dictionary says it is to unite metal surfaces or edges with solder. The old dictionary says that solder is a metallic cement. The newer dictionary says solder is a metallic alloy for uniting metal surfaces. The same dictionary says that the word solder or soldering is derived from the Latin, *solidare*, to make solid. The dearth of information given in these dictionaries is remarkable and is only equalled by the definition of brazing, which is given in Webster of 1877, viz., to cover with brass. The dictionary man has evidently progressed somewhat in his technical education, for the 1900 dictionary says, " Brazing, to solder with hard solder, especially with the alloy of copper and zinc."

Definition of Soldering.

In reality, soldering is the joining of similar or dissimilar metals by means of an alloy which has a lower melting point, though this is not always the case. According to modern practice, soldering means the uniting

of two or more pieces of metal with an alloy of lead and tin. The usually accepted theory of soft soldering is that the molten soft metals, when under certain well known conditions, adhere to and unite with the metals being soldered, at a temperature less than the melting point of the metals in question, but greater than the melting point of the solder or uniting alloy.

Burning or Autogenous Soldering.

There is a method of soldering which is used extensively when tanks are lined with sheet lead, which is known to the trade as "lead burning," but this operation should not be confused with soldering. Lead burning is really a form of welding and a newly developed system of autogenous welding, which is coming into quite general use. It is nothing more nor less than a "burning operation," almost exactly like lead burning.

It is possible to unite tin and similar metals with low melting points, by melting their edges or surfaces together, but this is not truly soldering. In lead burning, the two surfaces are united by means of a strip of similar metal, which is used as solder and is melted into and with the metals to be joined. Thus in lead burning, the surfaces of the metals to be joined are actually melted, while in true soldering, the surfaces are not melted but are heated to a degree much less than their melting points and only a little hotter than the melting point of the alloy, which is used as solder.

Solders Commonly Used.

The alloys most commonly used in soft solder have a wide range in their melting points. Some of the solders, notably those made chiefly of tin and lead, melt at a temperature as high as 500 to 600 degrees, while ordinary soft solder melts at 300 to 500 degrees. Solders may readily be made which will melt at any temperature down to 120

degrees or much less than the temperature of boiling water. Such solders are of little use commercially, being used mostly for exhibition purposes, for tricks and amusement. There is a notable exception in the automatic sprinkler head, which is closed by a drop of solder, which melts at a very low temperature and which, when melted, permits water to escape from the sprinkler and extinguish the fire which caused the rise in temperature to the degree which melted the solder.

Fusible Plugs for Steam Boilers.

Another use for low temperature solder or alloy is for filling fusible plugs, one of which is required by law in certain States to be placed in each steam boiler or generator. It is found, however, that although such a plug may be made to melt at any required temperature, that it will not melt at that degree of heat after it has remained in use for a considerable time. Being continually subjected to heat and pressure seems to change the character of the alloy so that the melting point continually grows higher; after plugs have been in use for a year or two they will not melt at the temperature of steam.

To obviate this difficulty, steam boiler specifications call for plugs filled with blue Banca tin, a metal, the melting point of which is not affected by continued heat. Still another application of low temperature alloys or solders is the uniting or mending of utensils made from block tin or of Britannia ware. Some very soft solders are made from the alloy of bismuth, still others contain mercury and by the use of this metal, solders may be made which will melt at any required temperature above 40 degrees Fahrenheit and below zero. It will thus be seen that the temperature range of solders is unlimited.

A very pretty operation is the making of a low temperature solder which will melt by the warmth of the hand and which will harden again at the ordinary air temperature

of 70 degrees. Such solders are of very little commercial use save for making models and illustrating methods of doing work in the shop or in the school.

The following table gives the composition and melting points of various alloys, which may be of use in soldering. From this table the workman may take out a formula for making a solder, which will fill any condition likely to arise in the most extensive practice.

Alloys and Their Melting Points.

No.	Bismuth.	Lead.	Tin.	Cadmium.	Mercury.	Melting point.
1	2	1	1		10	113
2	4	2	1	1		149
3	7	3	3	2		160
4	4	2	1	1		165
5	2	1	1			200
6	4	1	1			201
7	10	1	1			201
8	5		3			202
9	8	5	3			202
10	12	7	6			203
11	8	3	5			208
12	5	1	3			212
13	5	3	2			212
14	5	1	4			240
15	1	1				257
16	1		1			286
17		1	3			334
18		2	3			334
19	1		2			336
20		1	2			360
21	1		3			392
22	1		8			392
23		1	1			466
24		2	1			475
25	7	3	3	2		Very low.

Silver Soldering.

Silver soldering is really a form of brazing. Silver solder is usually known as hard solder, and is thus distinguished from soldering with the copper and alloy of lead and tin. Silver soldering is usually performed with the blow pipe, the articles to be soldered being wired together or otherwise held securely in place during the fluxing and heating operation. The best work in silver or hard soldering is secured when the parts are fitted together as closely as possible; the better the fit, the better will be the soldering.

A joint may be made perfectly by drilling a hole through both pieces of metal and joining them by means of a rivet, which may even be countersunk, and riveted at each end. If such a joint be subjected to hard soldering or brazing, the silver or brass will, if the soldering be properly done, find its way along the rivet, through the drilled hole, and show itself at the opposite end of the rivet, no matter how tightly it may fit. The operation of silver soldering will be described in detail in another chapter.

Fluxes and Fluxing.

A great variety of fluxes may be used in soft soldering, in hard soldering and in brazing. Fluxes are used in soldering to prevent oxidization of the heated surfaces, both of metals to be united and of the uniting alloys, also to render the solder more fluid and thereby to penetrate better into the interstices between the parts to be soldered. Taking this view of the matter, it will be seen that almost any substance will serve as a flux which will melt and coat itself over the heated surfaces without being disturbed by the heat.

Common resin is the flux universally adopted for tin and brass—in fact, for soft soldering in general, for the reason

that it will withstand a temperature which enables it to melt and spread over the surface of lead and tin without being driven off in a gaseous condition. For soldering lead, particularly when joints are to be wiped, the plumber uses tallow, which seems to be the best flux for this metal. Resin may be and is used when soldering lead with the copper, but tallow works well and is handy when resin is not obtainable. In fact, cylinder oil, or any heavy grease, may be used, which will protect the surface of the metal from attack by oxygen of the air.

Lead and Tin Oxidization.

When metals are heated they are very readily attacked by oxygen. The dross which gathers in the molten metal in the ladle is an example. The dross is nothing more or less than oxide of lead caused by the union of metallic lead from the ladle with oxygen from the air. When lead or tin are in the solid form they are less readily attacked by the atmosphere. A very thin film of oxide forms almost instantly over a freshly cut surface of lead or tin, but this thin layer seems to protect the metal against further oxidization at ordinary temperature. It is for this reason that tin and lead seem to be free from rust, while they are actually covered with a very thin layer of rust or oxide, which effectually prevents further action of the elements.

A proof of oxidization is found in the odor which constantly arises from a piece of new tin. By pouring some water on a sheet of tin or into a new tin dipper, and holding it to the nostrils, one will readily detect the peculiar odor of tin, which shows that a coating of oxide has been formed over its surface by the union between metallic tin and oxygen.

Borax a Universal Flux for Hard Soldering.

Borax may be used as a flux and for brazing and hard soldering. Borax or boracic acid are the agents universally employed for that purpose. Resin will not stand for brazing, because of the high temperature necessary, which drives all the resin into gaseous form and it becomes dispersed or lost before the brazing operation can be performed. Borax will melt over the surface and form a coating of glass, so to speak, which remains until the brazing operation has been completed.

Borax is also the proper flux for welding operations. Silica is used to a great extent in rough welding jobs, and for this reason a smith covers pieces of iron to be welded with fine white sand, which is nearly pure silica. It may not be known to all solder users that steel may be welded when lime is used for flux, nearly, if not quite as well, as when borax is used. In fact, limestone is the natural flux for steel.

Selecting a Flux.

The tinner or the plumber may make use of his knowledge of fluxes by being able to substitute one for another when he cannot obtain the particular flux commonly used for a certain kind of work. Thus if he is using solder which melts very hard and requires a high degree of heat in the soldering tool, he can mix some powdered borax with the resin and thereby obtain a flux which will prevent soldering coppers from burning, even when heated nearly red hot. He may also be able, when it is necessary to carry the pot of hot metal a long distance, to cover the surfaces of the metal with borax and charcoal or borax and lime, under which, though the metal be heated red hot, hardly a particle will be lost in dross or oxide during the journey from point of melting to point of using.

Reducing Oxides.

By incorporating certain chemicals with the flux, the oxide or dross arising from any metal may be changed back again into solid metal. This is called reduction of oxide, and is the same process, or is carried out in the same manner, that is followed when the ores of lead, tin, etc., are smelted to obtain from them the metal. If the fluxes be made of charcoal, common salt and soda, the dross will be reduced, as the chemist calls it, to the metallic state again.

The tinsmith and plumber should not permit dross to form when heating soft metal, and if any does form, either through poor management or through ignorance on the part of the workman, the dross or oxide should be carefully saved, and when a sufficient amount has accumulated, enough to fill a ladle, it may be packed in the ladle in layers alternated with layers of charcoal flux. If the ladle be now heated to a proper temperature and the heat maintained for a few hours, the dross will be found to have disappeared and in its place will be a quantity of bright new metal.

Soldering Tools, Appliances and Methods.

The most common of all soldering appliances is, beyond doubt, the time honored and much abused soldering copper, " the soldering iron " as it is usually called. It must be stated, however, that the modern tinner and plumber is more apt to say " copper " than to tell about the " iron."

The soldering copper is so common and so well known that at first sight it would seem superfluous to give a description of that important tool, but notwithstanding this there are many working tinsmiths who cannot, under any circumstances, name the different sizes and shapes of cop-

pers in use in up to date shops. On the other hand, it is quite likely that the tinner would describe his soldering tool as a "chunk of copper with a handle stuck in the end of it," and it must be confessed that this description fits very closely to many of the coppers found in some shops.

Common Forms of Soldering Coppers.

Two types of tools for soldering are shown by Figs. 1 and 2, the former representing the usual straight bit, the uses of which are almost universal. Fig. 2 shows the modern form of hatchet bit which is also a tool largely used. In fact, there are few soldering jobs which cannot be performed with the aid of these two standard coppers.

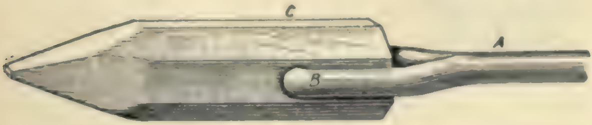


Fig. 1.—Straight Copper.

Fig. 2 shows a good form of hatchet copper, the head of which is swivelled and may be moved in any direction to make it do the work in hand. The straight copper shown by Fig. 1 is held to the handle by the clamping device shown, viz., a couple of holes drilled in the bit and the split ends of the handle inserted therein. Channels on either side of the bit between each hole and the end of the copper are made to receive the handle as shown. In the illustration, the handle is welded at A, but many handles are made of a single piece of round iron, bent back on itself and the ends twisted together before being driven into the holes in the copper, as shown at B and C.

Personally the writer does not like this kind of handle: it is very apt to get loose in the bit and rattle about at

B and C, allowing considerable play to the end of copper D. The writer prefers the form of handle shown with the hatchet tool, Fig. 2, the handle of which is welded together at E, in a manner similar to that shown at A, Fig. 1. The metal handle is then made of the required length and a wooden shell F, Fig. 2, is applied as shown. The washer G is brazed or soldered securely to the metal handle and the wooden shell has a hole bored through its entire length to receive the metal handle G. The extreme

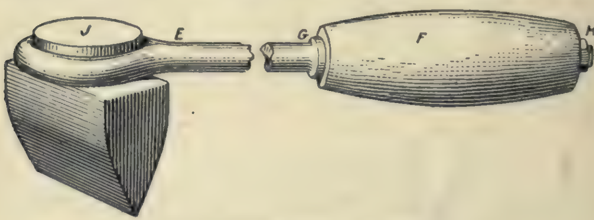


Fig. 2.—Hatchet Copper.

end of this handle is threaded to fit nut H and carries another washer, which, when screwed down against the end of shell F, holds it securely under almost all conditions of use.

Coppers with Wooden Handles.

In some coppers the wooden handle is replaced by a piece of steam pipe; a piece of brass pipe ½ an inch in diameter makes a fine looking handle when fitted with a couple of soldered-in ends, but both the brass and iron pipe conduct heat very rapidly and are apt to become much hotter than plain wooden handles. Fancy handles are sometimes made of leather or rawhide washers cut out, placed upon the handle and the nut H screwed down when the washers are filed to a shape which fits the hand.

When a hatchet copper gets loose in the swivel it may be tightened by screwing the lower portion of the bit in a vise and riveting down the upper portion until it pinches the handle E, as tightly as necessary.

A Household Soldering Copper.

Neither the hatchet copper nor the straight copper should ever be permitted to become rounded at the point. A tool resembling Fig. 3 is very often to be found in tin shops, and such a tool should never be permitted under any conditions whatever. Its presence in the shop is evidence that some one of the men is not attending to business

Fig. 3.—Household Soldering Copper.

properly. While soldering may be done, after a fashion, with such a tool, it is best to do work in a commercially profitable way.

The only place where a bit of this kind should be found is in the homes of your customers. This bit may well be called the household soldering copper, and when a man who is possessed of such a copper thinks of doing his own tin mending, he is pretty apt, after one or two trials, to bundle up his work and bring it to the shop. Whenever a copper shows any tendency to approach Fig. 3, in condition and appearance, just bundle that copper over to the blacksmith and have it put in shape again.

Forging Coppers to Shape.

Coppers may be kept in shape by forging. All smiths may not be aware of the fact that copper can be forged on the anvil as readily as iron or soft steel. One can forge coppers, however, if a piece of heavy iron is at hand to work them on. Just heat to a bright red, then draw them out with a round faced hammer. There will be no danger of spoiling the point of a copper during the drawing-out process if it is hammered on all four sides equally. Don't try to do all the hammering necessary on one side at one time, but divide up the blows, turning the bit back and forth so that only a few blows are struck on any side at one time. Never try to draw out a round copper without first squaring the end thereof. If a round copper is hammered from all sides the metal will surely split in the middle or crack into several pieces. First hammer the round bit into square form and in that shape draw it down to the required dimensions; then, if a round section of bit is required, make it round by lightly hammering after it has been drawn down into the square form.

Some tinners, when they find a bit approaching the form shown in Fig. 3, proceed to file off a lot of metal and bring it to shape in that way. This is a waste of copper pure and simple, and it should never be done. Simply heat the coppers to a red heat and draw them out on the anvil to the correct form, as described above.

Special Forms of Soldering Coppers.

It would require too much space to describe all the special forms of coppers that are to be found in general use. It must suffice to state that coppers may be procured of any required shape. The dealer carries many stock sizes and shapes and the brass foundry will give you special

coppers at any time, provided a wooden pattern is furnished of the desired shape. Just whittle out a bit of soft wood to the size and shape of the required bit, hand this pattern to the brass foundryman, and he will supply a bit, true to the pattern, which may be fitted with any desired form of handle. Such special coppers may well be fitted with a cast-in handle. Just a plain piece of $\frac{3}{8}$ inch or $\frac{1}{2}$ inch rod is all that is required. Hammer one end a trifle to enlarge it so that it will not pull out of the copper bit should it become loose therein. Pass this handle along to the brass foundryman with the wooden pattern; he will place the handle in the mold, pour the copper around same, and in a short time he will hand you the complete tool ready to be tinned and put to immediate use.

Shape and Size of Coppers.

Do not hesitate about providing plenty of soldering coppers of varying sizes and shapes; it does not pay to use a little picked copper for soldering a long, heavy seam. A heavy hatchet tool is the better one for that purpose, but if a man wishes to solder up a pinhole in a tin pail, he has no use for a 3 pound hatchet tool, but should use the smallest copper available. Don't hesitate to purchase new tools of special shapes; it is much better to do so than to change over existing shapes, which are sure to be needed sooner or later in their original forms.

A Wire Soldering Copper.

For some kinds of very light soldering, a piece of copper wire is all that is necessary. A No. 16 copper wire, with a ring turned in one end for a handle, makes a most convenient tool to use when soldering with the blow torch

or blow pipe. One of the handiest tools the writer ever used is shown by Fig. 4. It is nothing more or less than a piece of $\frac{3}{8}$ inch copper wire, the same as is used as a feed wire by trolley lines. An eye is turned in one end for a handle; the other end is flattened on one side and filed to a double angle on the other side as shown. This is one of the handiest tools imaginable for working into small corners and is used in connection with a blow torch.

In model work, particularly where all sorts of pieces have to be soldered together, this tool is very convenient indeed. It is only necessary to place and hold the articles

Fig. 4.—Handy Soldering Tool.

n question, blow them a few seconds with the gasoline torch, then work the solder into place by means of the tool illustrated by Fig. 4. Several of these little tools will be found advantageous. The writer uses one occasionally which is only 1-16 inch in diameter.

A great improvement in tools of this kind is to braze a short section of copper to an iron rod of smaller diameter, which will serve as a handle. Iron does not conduct heat as readily as copper, and by making the handle smaller than the tool the metal has less conducting capacity and the copper stays hot much longer than when the handle is of solid copper and of the same size as the tool.

CHAPTER II.

TINNING SOLDERING COPPERS.

Even the apprentice quickly realizes that a soldering tool is of little value unless it is well tinned. Soldering can be done with untinned or poorly tinned tools, but it will be a poor job at best and a slow, costly one as well. The writer used to know one party who did all his own household soldering, mending pots and pans with soft solder, with no other soldering tool at his command than the tongs from an old-fashioned fire place. These tongs were iron and, of course, were not tinned, but the person in question used them so long and soldered so much, that the disks at the end of the tongs were worn almost entirely away. This person actually did quite creditable work with the old tongs and if he had been equipped with a soldering outfit, he would have been a success at the business.

Clean Coppers before Tinning.

When coppers are to be tinned, the first step is to remove the coating of oxide which always covers a copper. It is utterly impossible to make solder adhere to a copper or any other surface which is covered with dirt or oxide, hence before a copper can be tinned it must be made absolutely clean. Being clean, in the sense used by tinners, means free from all oxide of its own and of other metals. It makes no difference how much grease or gum or resinous substance there may be on the surface as long as

it is free from a film of dross or oxide. As stated elsewhere, oxide is the technical name for dross which is formed by the oxygen of the air attacking any metal, copper, lead and tin in particular.

Protect Bits from Air.

In order to obtain a clean copper surface, it is absolutely necessary that air be prevented from coming in contact with the copper after it has been cleaned. No matter how well the surface of a copper bit may be filed or ground, it requires less than one second's exposure of the heated copper to the atmosphere to form a film of oxide over the surface of the metal and then the tinning possibilities are over, for copper in that condition cannot be tinned, try as hard as one may.

The Tinning Problem.

The tinning problem thus resolves itself into three parts. First, the cleaning of the copper. Make it bright and free from all metallic oxides. The second step is to keep the copper in that condition until the third operation can be completed, which is the covering of the bright surface with a film of lead and tin alloy.

The first operation we have described; it is done by filing, sand papering or scraping the surface of the copper until it is clean and bright. The second operation, that of keeping the copper clean until it can be tinned, can be effected in two ways. First, by means of a flux, second, by means of an acid. Resin is the flux usually employed for this purpose and its office is to spread itself over the surface of the hot copper in such a manner that no air can reach the bright portion.

Acid Method of Cleaning Coppers.

The second way, the acid method, is effected by dipping the copper into a solution of muriate of zinc. The acid attacks the surface of the copper, removes the oxide therefrom and replaces it with a thin film of zinc, to which the solder will join itself if applied immediately. The zinc does not seem to oxidize as quickly as the copper, but if that copper be allowed to remain any appreciable length of time after dipping in the acid, before the solder is applied, then the alloy will not spread well over the surface and the tinning operation will be a failure until the hot copper has again been dipped in acid. For tin work, brass soldering, uniting lead surfaces and similar work, the resin method is preferable. The copper may be filed to a bright surface, rubbed with a piece of resin and then tinned by rubbing a stick of solder over the prepared surface.

Tinning Coppers with a File.

The critical point is the applying of the resin to the bright surface before the latter is exposed to the air after cleaning. To accomplish this some tinners rub the copper smartly on the floor over which a little sand has been spread, then apply the resin to the solder. Tinning may also be done by placing the hot copper with one of its surfaces nearly level, then placing a bit of resin on the surface which is then scraped with an old file. This removes the oxide and brightens the surface, which is immediately covered by the resin, thereby preventing access of air and the consequent formation of a dross film.

This operation is shown in Fig. 5, in which a little pool of melted resin is shown on the surface of the copper at A. A little globule of solder is shown at B, which was melted

from the stick by the heat of the copper. As far as this copper is kept bright with the file, the resin will flow over it and when the file reaches the globule of solder, that alloy will also spread over the copper underneath the resin. By working in this manner over each portion of the copper

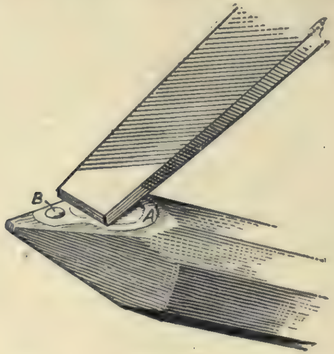


Fig. 5.—Tinning with a File.

the tinning operation may be completed in less time than it takes to tell it.

Tinning Two Coppers at Once.

Some people prefer tinning two coppers at once, as shown by Fig. 6. This method works pretty well, especially on coppers which have been tinned before. It is about like the file method, only one copper is used to scrape the other clean instead of the file used in Fig. 5. Some resin waves are shown at C, and as they are pushed aside by the rubbing operation, it will be found that there is a coating of solder underneath them. Each of the four sides of the copper must be subjected successively to the rubbing operation, and it is evident that the two coppers may be tinned

in this way during the time required to tin one copper by the file method.

Fig. 6.—Tinning Two Coppers at Once.

Tinning Coppers with Salammoniac.

A third method of tinning is shown by Fig. 7. This may be known as the salammoniac process. That substance

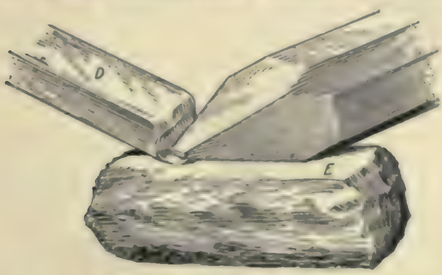


Fig. 7.—Tinning with Salammoniac.

(muriate of ammonia) comes in large and small crystals or chunks, and is well known to the tinner and plumber as being particularly useful when copper surfaces are to be tinned. A chunk of salammoniac is kept upon

the bench. With the stick of solder in the workman's left hand, the right hand moves the copper back and forth upon the salammoniac with a scraping motion. The mechanical action of the motion, together with the chemical action of the salammoniac penetrates and removes the film of oxide on the copper and soon brightens its surface. Occasional contact with the stick of solder, D, causes some of that substance to adhere to the bright copper, while some of it is deposited on the salammoniac, E, and thence is rubbed over the surface of the copper, resulting in quickly giving that tool the requisite coat of alloy. This method of tinning is particularly desirable when soldering galvanized iron. "Raw" acid (muriatic or hydrochloric) is used for this purpose, and frequent renewing of the tinning on the copper is necessary.

The Brick Method of Tinning Coppers.

For general use the writer prefers the brick method shown by Fig. 8. In this illustration the copper, F, is represented as being moved back and forth in the shallow groove, G G, which has been dug in the surface of brick, H. Some resin, I I, has been melted into the cavity, which is only one-eighth or one-quarter inch deep. Some solder is also melted in with the resin. A couple of globules are shown at J J. A very soft brick should be selected for making one of these tinning tools—in fact, the softer the brick the better, and the more the brick crumbles or wears away as the copper is rubbed against it, the better and quicker will the tinning be accomplished.

The theory of this method is that the hot copper, by rubbing upon the brick in the bath of melted resin, is completely protected from the air, while the gritty substance of the brick quickly polishes the surface of the copper. The resin protects the surface as fast as it is cleaned,

and the solder being present at the time of cleaning and polishing, immediately adheres to the copper surface. In making up a new tool of this kind, it is not necessary to cut the channel G, G. It is better to drive a cold chisel across the top of the brick a few times, leaving most of the brick dust in the channel. Melt in a piece of resin as big as a hen's egg, put in a chunk of solder or the refuse drops scraped from the bench or floor and proceed with the tinning.

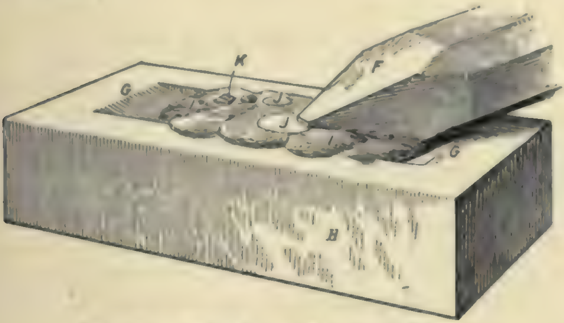


Fig. 8.—Tinning with a Brick.

This method is a combination of about all the other methods shown, except the salammoniac method, Fig. 7. The writer sometimes finds it convenient to add this method also to the brick way of tinning, by scattering in with the resin a few fragments of salammoniac, as shown at K. Some fragments of this substance may be used on the brick to advantage, and, if desired, some powdered salammoniac may be mixed with the resin, with most satisfactory results.

This method is the quickest way of all for tinning coppers. When the writer is doing soldering of almost any description, in which a copper is used, he likes to have

brick H at hand upon the bench. Whenever the copper, upon being removed from the fire, shows a few spots where the tinning is thin or defective, a rub or two on the brick will restore the copper to a perfectly tinned condition. When tinning small objects, such as pieces of wire, little clips or bits of steel or iron, the brick is also useful. Dipping first into acid and then into resin will, with one or two rubs with the copper F, put an immediate and perfect coat of solder upon the articles to be tinned.

The Simple Soldering Tools.

The coppers and tinning apparatus above described are those which can be used in most soldering jobs where labor saving conveniences are not to be had. The electrical soldering copper is a tool which will be described later, but it is not usually found in the outfit of the ordinary shop. The coppers and tinning conveniences noted above, with the addition of a few scrapers and a pair of tinner's shears, a hammer, mallet and a file or two and perhaps a pair of compasses, make up the list of economical and indispensable tools.

The Scraper.

A triangular piece of steel fitted with a handle is well known in the tin shop and its chief characteristic seems to be that of being as dull as a hoe. It is very seldom that the scraper is ground, though it should be kept as sharp as any wood-working tool. A soft scraper, one that can be touched up with a file, should be thrown away. When picking out a scraper, test it with a file and select one which the file will not touch. If by chance you have a soft scraper, heat it to a dull red heat, taking care that the heat is as evenly as possible, then plunge it into cold water

and move it from side to side while cooling. This movement is to dislodge any bubbles of steam which collect on the steel and prevent the contact of the water, thus reducing the hardness of the metal.

Tempering a Scraper.

It may be necessary after such a hardening to tighten the rivet which holds the scraper to its handle and possibly it may be necessary to draw the temper a little for, if made from high grade steel, the scraper may be broken if struck with a hammer, or otherwise misused. To draw the temper, pass the scraper blade back and forth before the blaze of a gasoline torch or any kind of a fire pot. Watch closely and when the faintest tinge of bronze is seen, remove from the heat and allow the scraper to cool. Sometimes a corner or an edge may show a faint color before the rest of the scraper begins to change; in such a case touch a wet rag to the place which shows color. This stops the temper from running down and the remaining portion of the scraper can be brought to the required softness without the "running out" of the temper over the portions which show color first. Only the faintest tinge of bronze or orange should be permitted, or the scraper blade will become too soft.

Case Hardening a Scraper.

When a blade will not harden by heating and quenching in water, it should be treated with yellow prussiate of potash. Heat the steel to a low red heat and apply the potash just as borax or resin would be applied in the process of soldering. After the potash has been applied, maintain the low, red heat for ten or fifteen minutes. If the potash burns out on any portion of the steel, then ap-

ply a little more of the chemical, which will form a thick, liquid coating over the steel.

After the time mentioned has expired, heat the steel to a good, red heat and quench in water, as before directed. The prussiate of potash goes around the outside of the soft steel and that portion of the scraper may be made very hard while the interior remains as soft as ever. The longer the steel is subjected to the action of the potash, the harder it will become. If it is found not hard enough after the operation has been completed, the case hardening may be repeated as many times as are necessary; but thin steel, such as scrapers are made of, may be hardened entirely through and thus become very brittle and will break easily unless the temper be drawn as directed for ordinary steel.

Old File Scrapers.

Old files make excellent scrapers for cleaning dirt or paint from seams which are to be soldered. To prepare files for this work, grind them as though they were chisels, then use as a chisel would be used when scraping a seam. The scraping must be done with a pushing instead of a pulling motion, as with the triangular scraper, which is intended to do the work on the drawing stroke.

Heating Soldering Coppers.

The old-fashioned charcoal fire has become almost a thing of the past. Very few shops, except in remote country places, now use the charcoal pot. In its place may be found the gasoline blow torch, and pots using gasoline are made for all kinds of ordinary work, also for special work. For shop work the gas heater has become almost the rule. Any ordinary coal fire pot may be readily converted into a gasoline heater by placing inside a form of

Bunsen burner made specially for heating coppers. This burner is in principle like all other burners of the Bunsen type and consists of a wire gauze hood, through the meshes of which gas and air, mixed in proper proportions, are driven.

The Gasoline Blow Torch.

An important addition to the heating apparatus for soldering purposes is the gasoline blow torch, consisting of a gasoline-containing vessel made air tight and fitted with a form of air pump whereby a considerable pressure of air may be maintained above the gasoline while the device is in use. The gasoline, under pressure, is forced through the pipe into a Bunsen burner. A Bunsen burner, by the way, is a device whereby gas is driven into a tube much larger than the gas supply pipe, which pipe acts as an injector to force the gas into the tube. The injector draws into the tube with the gas a quantity of air which mixes with the gas before it reaches the burner proper.

A wire gauze shield or a thin plate perforated with very fine holes, prevents fire from igniting the mixture of gas and air before it gets to the burner. It is a peculiarity of flame, that it cannot pass through very small tubes or openings, and this fact is taken advantage of in constructing the Bunsen burner or a miner's safety lamp. By means of a proper mixture of air with the gas, the latter loses its light-producing quality and the resulting flame is blue, giving intense heat and but very little light.

In using a Bunsen burner for soldering, the air supply should be so regulated that the flame is a very deep blue or even violet, if possible. The bluer the flame, the hotter it will be found. The higher the temperature, the more perfect the combustion and the less will be the gas consumed. The Bunsen burner may be operated with any kind of gas, either illuminating or acetylene, and it may

also be operated with ordinary gasoline vapor. In the gasoline torch, as the name implies, that substance is used to supply combustion.

The improved form of gasoline torch has its air pump in the handle A, Fig. 9, and the needle valve is fitted with a bent handle B, which being covered with some poor conductor of heat does not become as hot as in some of the

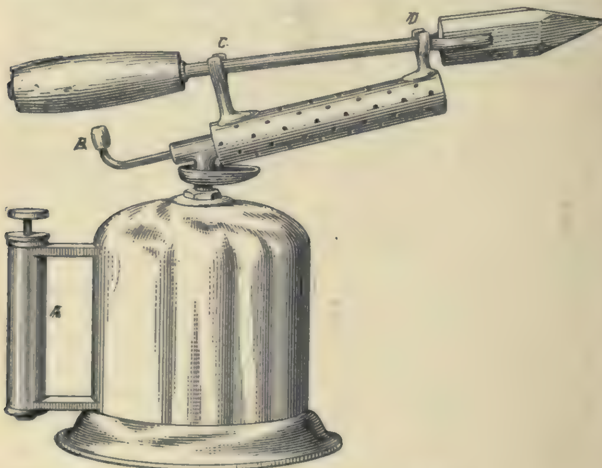


Fig. 9.—The Gasoline Torch.

older forms of torches. Some torches are fitted with little brackets at C and D, whereby a copper may be laid on top while being heated. This is a very convenient arrangement. The tinner who is unaccustomed to handling blow torches will probably have trouble until he becomes fully conversant with the tricks and traits of blow torches in general. He may be troubled by the torch extinguishing itself easily whenever the blaze is turned to a low point;

sometimes this is due to roughness of the needle point, which roughness diverts the stream of gasoline against one side of the perforated combustion shield. When this trouble is met with remove the needle and see that the point is made smooth and that it is clean and free from rust.

Leakage in Blow Torches.

More trouble is met with in leakage of air. There is a valve between the pump and the gasoline reservoir which sometimes, but not often, fails to hold. This valve is submerged in gasoline or at least has gasoline on one side of it—on the pressure side—hence any leakage of this valve will be known by gasoline coming out of the pump. Another source of leakage is through or around the filling plug. Underneath the lamp will be found a screw plug, so constructed in the later forms of torches that it may be tightened by a wrench or by putting a punch through the hole in the plug. A piece of leather is fitted around this plug and when leakage occurs the tinner should look to this plug and see that it and its packing is in good condition.

Gasoline leakage will occur also whenever packing becomes defective. If both the torch and the plug are kept very clean and every particle of dirt removed before they are screwed together, there will be little chance of leakage around the packing washer, but if dirt and particularly metal filings are permitted to adhere thereto, the washer will quickly fail to keep the joint tight.

Air Pump Leakage.

The remaining source of leakage, except, of course, holes in the reservoir, is in and around the air pump. This appliance is of the usual bicycle pump construction,

with a leather cup which serves as a plunger valve. A few drops of oil placed in the pump, around the rod, and allowed to run down upon the leather, will usually remove leakage troubles at this point. Sometimes, however, the leather packing becomes too badly worn to fit the pump barrel, even when pressure is applied by the hand. In such cases carefully cut out, form and put in a new plunger cup; soak the leather in water until it can be shaped to the proper form and after it has become dry in the barrel, stuff it full of oil, which should be frequently renewed, as gasoline or its vapor rapidly extracts oil from the packing and from all portions of the pump.

The usual source of air leakage is around the pump barrel, where it is screwed into the reservoir. Another packing washer will be found at this point, which washer should be put in and kept in a smooth condition, the same as the washer around the filling plug in the bottom of the torch. Sometimes the torch extinguishes itself mysteriously and fails to start again until it is struck a more or less severe blow with a hammer. Sometimes this fault may be traced to dirty gasoline. It is well when filling a blow torch to avoid shaking the gasoline can and carefully pour in the necessary amount without stirring up any sediment which may be in the bottom of the can. Such gasoline should be strained through several thicknesses of cloth, excelsior or some other dirt removing substance. Sometimes a torch fails to work properly because the air holes in the perforated burner hood have become closed. In such a case the tang of a file or end of a sharp reamer may be used to advantage in cleaning out the holes.

Starting a Blow Torch.

In starting a blow torch it is supposed that the tinner is aware that the burner must become heated hot enough to vaporize gasoline before it will give a blue flame. When

a blow torch puts out a white or yellow flame, the operator should know that the burner has become too cold to work properly. This may result from too much gasoline, and the tinner should immediately correct this fault by making the torch put out a blue flame before he tries to heat coppers or to solder with it.

A Blow Torch Furnace.

To obtain a high degree of heat from the blow torch, so as to heat two or more coppers at the same time, place two pieces of board adjacent to each other, or nail up a rough box without ends or top, as shown by Fig. 10.

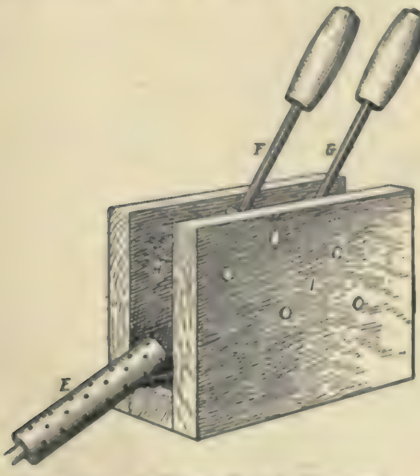


Fig. 10.— A Blow Torch Furnace.

Three pieces of board are all that are necessary for this purpose. Block up under the boards until the gasoline

torch can deliver its heat between them, as shown at E, where the burner of the torch is pointed between the boards. Two or more coppers may be placed between the boards and quickly heated at the same time. The coppers, F and G, are simply thrust between the pieces of board upon some wire nails which have been driven through one of the boards for the coppers to rest upon. One of these nails is seen at H and the heads of the other nails at I, showing how they are driven in an irregular manner into the pieces of boards.

This arrangement of boards will, of course, burn out in a short time, but it will last much longer than would be supposed. A device made, as shown by the engraving, of common one inch boards, may be used for several hours before it goes to pieces. The theory of this method of heating copper is that the wood is quickly turned into charcoal by the intense heat of the torch and becoming ignited, a much hotter fire and a much larger one is made than is possible with the blow torch alone. In fact, if the opening between the boards is packed with charcoal or small pieces of wood, a blaze can be obtained between the boards which will almost melt brass or copper.

A very good furnace for heavy work may be made by piling up three or four bricks in such a manner that the coppers may be placed inside and the flame from the blow torch bear directly upon them. With the addition of a little charcoal or small pieces of wood or even sawdust, in or around the coppers, a fierce heat may be obtained which can be equalled only by a smith's fire. This device is not only suitable for heating copper, but the blow torch furnace may be used for many brazing operations, as will be described in the chapter devoted to that matter.

The Blow Pipe.

Soldering by means of the blow pipe is practised very extensively by jewellers and mechanics who do very small and very fine work, but the blow pipe method of soldering is just as applicable to large as well as to small work, provided the blow pipe be made of a size proportioned to the work to be done. The blow pipe as used by jewellers, is a little tin or brass tube, large at one end, small at the other and from ten to twelve inches long. A mouth piece is arranged at the large end and a stream of air which issues from the minute hole in the small end of the pipe is directed against the flame of a lamp torch or candle.

This form of blow pipe is shown in Fig. 11, and at C is shown the blow pipe in position, in front of a candle.

Fig. 11.—Common Blow Pipe.

From the effect which the blast of air from the pipe has upon the candle flame, it will be noted that the flame is deflected to a nearly horizontal position. It will also be noted that there is, what may be called, two flames, one at A, the other at B, the latter seemingly inside of the former. There are two flames, in fact, as well as in appearance. The one at A may be drawn down to a very fine point and is called the oxidizing flame. The one at B is not as blue as the flame at A and is called the reducing flame.

Action of the Blow Pipe Flames.

To illustrate the action of both of these flames, direct the flame A upon some bits of solder and note how quickly the solder is oxidized or turned into dross. Then change the position of the blow pipe and candle, so that the reducing flame B be made to impinge upon the dross; it will be only a few minutes before the action of the reducing flame changes the oxide back into pure metal.

For this reason, it is best when soldering to bring the reducing flame against the work as much as possible. This means the pushing of the blow pipe forward until the inside flame reaches the point to be heated. If the place to be soldered is larger than the pencil of flame which reaches it, then move the blow pipe to and fro, slightly directing the flame alternately over the entire surface which is to be brought to the melting point of solder.

When to Apply Fluxes.

Fluxes should be applied at the same time, or before the heat is turned on; sometimes the flux will not stay in place until the surfaces have been heated slightly, but in any case, the flux should be applied before the metal has become hot enough to oxidize easily. Usually a bit of solder will float over the surface and spread itself in all directions, by capillary attraction, as soon as it becomes melted, but sometimes when the surface is not quite clean or is not fluxed properly, there will be trouble in making the solder flow to some parts of the metal to be soldered.

When this happens, the tool shown by Fig. 4 should be brought into use and placed in the flame of the blow pipe until heated to the melting point of solder, when the tool may be used like an ordinary soldering copper, but right in the blow pipe flame, and the melted solder rubbed upon

the surface to be soldered until it adheres to and flows to the point where it is wanted. In soldering with a blow pipe, never try to bridge over any holes or wide places between metal surfaces. This is a trick easily accomplished with the soldering copper, but in blow pipe work the joints should be fitted closely together and carefully held in contact with each other while the solder is being applied. The same is true with blow torch soldering and directions given for blow pipe work are equally applicable to soldering with the blow torch.

CHAPTER III.

SOLDERS AND FLUXES.

Selecting Solder.

Two metal surfaces may be joined together with almost any alloy of lead and tin, or with either metal alone, but there is a certain proportion of each metal which makes an alloy best fitted for certain kinds of work. The table of lead and tin alloys on page 35 will enable the experienced tinsmith to select the alloy best suited to the work which he is to perform. Generally speaking, and for the guidance of inexperienced tinners, it may be stated that the softer the metal to be soldered, the stronger will be the joint after the work has been completed.

There are some exceptions to this rule, as to almost all others. When soldering ordinary tin, a solder made of equal parts of tin and lead is well adapted to general use. This is well known as the "half and half" solder. For more difficult work, such as wiped joints for lead or brass, a solder having great tenacity in a fluid or semi-fluid state is required. In cases of this kind the workman will use a solder with a large proportion of tin. As the scientist puts it, "very rich in tin"; as the machinist expresses it, "two-thirds or three-fourths fine." He distinguishes between alloys of lead and tin by calling them "coarse," "medium," "fine," etc. Thus a coarse solder for roofing work may be largely composed of lead.

As stated above, for wiped joints, a solder alloy must contain more tin. For soldering certain soft alloys known as

white metals, pure tin is sometimes used, but for still other and more fusible alloys the mechanic must choose one of the bismuth alloys when selecting a solder for the work in hand.

The following list of solders shows the work to which they are particularly adapted, and while they may be used, of course, for other purposes, they will be found more suitable for the work for which they are designed.

Selected Solders.

The following table of alloys and their melting points was compiled from various sources, among them "Kent's Engineering Handbook." The melting points there given have not been confirmed by the author, but were taken as given by Kent. Brannt, in his "Metal Workers' Handbook," gives a list of twelve solders, made up of lead and tin alloys, in which the proportions and melting points vary greatly from the table given by Kent.

Table of Lead and Tin Alloys, by W. F. Brannt.

Number.	Parts. Tin.	Parts. Lead.	Melts at Deg. Fahr.
1	1	25	558
2	1	10	541
3	1	5	511
4	1	3	482
5	1	2	441
6	1	1	370
7	1½	1	334
8	2	1	340
9	3	1	356
10	4	1	365
11	5	1	378
12	6	1	380

The author of the table further states that solders from No. 4 to No. 8 are used with tallow as a flux, and that No. 8 may be used with a mixture of resin and sweet oil when soldering lead and tin pipes. He also recommends No. 8, provided chloride of zinc or resin be used as a flux, for soldering Britannia metal, cast iron and steel, but that common resin or salammoniac be used with the latter metals. He also advises that No. 8 be used for soldering copper, brass, gun metal, etc., using either salammoniac, chloride of zinc or resin as a flux.

Plumber's Sealed Solder.

No. 5 solder is commonly used by English plumbers and is assayed and stamped by an officer of the Plumbers' Union. When thus tested and marked it is known to the English plumber and the trade as "plumbers' sealed solder."

In order that the tinner may not fall into error by depending upon erroneous melting points given by various authorities, it may be stated that the melting points of similar alloys, according to Kent, and as given by Brannt, are as follows:

Comparison of Solder Melting Points.

		Kent.		Brannt.	
Tin.	Lead.	No.	Melting Point.	No.	Melting Point.
3	1	17	334	9	356
2	1	20	360	8	340
1	1	23	466	6	370
1	2	24	475	5	441
1	3			4	482

The hard solders vary greatly in composition, according to the metals they are to be used with. An exhaustive description of hard solders, and the metals from which

they are derived, will be given in the chapters devoted to hard soldering and brazing.

Method of Making Solder.

Solders may be purchased ready made, but in many cases the mechanic finds it advisable to make his own solder, especially for special work. It will pay to use a porcelain lined kettle for making fine solders, particularly soft solders, because lead and tin alloy so easily with zinc and iron that the solder may be contaminated by merely melting it in an iron ladle, some portions of that metal being taken up and absorbed by the solder, particularly while at the temperature necessary for fusing.

When making solder, weigh out the metals intended to be used, then melt the tin first, put in the lead next, which should be cut in small pieces or hammered into long strips and fed into the tin slowly. Stir continually, using a stick for the purpose. Wood is desirable for stirring solder, for the reason that the outside is turned into charcoal, which has a beneficial action upon the alloy. Were an iron rod used for stirring, some of that metal might be absorbed by the alloy.

Do not try to keep the surface of the metal clean while it is melting; on the contrary, it is well to keep the surface covered with a mixture of powdered charcoal and soda or borax. This will prevent formation of oxide or dross and will reduce to a metallic state some of the oxide which may already have formed on the surface of the hot metal. Stir the metal thoroughly with a piece of wood, as directed, and then pour into molds, which are preferably made of iron, and which are of the shape and size of those used for ordinary soldering sticks as purchased from dealers.

A Mold for Soldering Sticks or Bars.

While the iron mold is preferable, as noted above, the workman may make for himself a very inexpensive mold, which will answer every purpose, provided he does not wish to use it too often. To make up such a mold, plane out a stick of wood to the exact size and shape of the bars to be molded. From one to a dozen—any number, in fact—may be prepared and placed on a smooth board, side by side, from one-fourth to three-eighths of an inch apart. These sticks are patterns of the soldering sticks or bars; they should be made with considerable "draft," as the foundryman would call it, to enable the solder to come out of the mold easily after cooling.

Patterns for Solder Sticks or Bars.

After the pattern sticks have been placed as directed, upon a board, mix up some Portland cement, such as is used by concrete men, with two parts of fine sand and add water enough to give the mixture the consistency of cream. Pour this over the pattern sticks until they are covered to the depth of at least one-half an inch, allowing it to remain from twelve to twenty-four hours, until strong enough to stand handling, then turn the concrete mass the other side up, and pry out the wooden pattern sticks with a screwdriver or some other pointed tool. It is best to let the cement mold lie for a couple of weeks before using; keep it wet during that time; but, if necessary, the mold may be used in twenty-four hours after having been made, but it will probably go to pieces after one or two pourings of solder, while if allowed to harden or cure from two to four weeks it may then be used over and over again.

Dry Molds before Using Them.

Before using this mold, place it in an oven and dry thoroughly. It may be used without drying, but there is some danger that the moisture in the mold may cause the solder to sputter. Sometimes when the hot metal hits a small cavity filled with water, in the bottom of a mold, hot solder will fly several feet. Drying the mold, as directed above, will prevent any possibility of an accident from moisture. After drying, the concrete mold may be dusted with plumbago, powdered soapstone, or even whiting may be used to advantage. This will make the sticks of solder much smoother, and they will come out of the mold easier. A little heavy oil, such as is used in gas engine cylinders, may be brushed over the surface of the mold, which may also be sprinkled with resin if desired, but when resin is used the bars must be lifted out of the molds as soon as they set, for if allowed to remain until entirely cool the resin will cement them to the mold so strongly that the solder cannot be removed without danger of breaking the mold.

It should, perhaps, be stated that the channels formed by removing the pattern sticks from the mold should be connected to a main channel passing the ends of all the small channels. The cast, as it comes from the mold, closely resembles a gridiron, the sticks of solder forming the bars or grids. The main piece to which the bars adhere is known in shop vernacular as the "sow"; the small bars of solder hanging thereto are called pigs. A similar arrangement is used at blast furnaces for pouring iron from the smelter into merchantable forms, hence the term pig iron, with which we are all familiar.

Fluxes and Fluxing.

It was stated elsewhere that fluxes are used to prevent oxidization of metals, either of the solder or of the pieces to be united by the solder. A flux is used in certain other cases where it is desired to melt material not easily fused. In this case the substance used as a flux is more easily fused than the refractory material, and when once melted they seem to induce the melting of the refractory substance. Not only do they transmit heat better, but they seem actually to lower the melting point of the substance to be fused.

Mechanical Action of Fluxes.

An idea may be obtained of the mechanical way in which fluxes act as transmitters of heat by performing a little experiment with a hot soldering copper. Put a bit of solder between two thin strips of brass and try to melt the solder by applying a clean copper to the opposite side of one of the brass strips. Unless the copper be very hot indeed, it will be found a slow and sometimes impossible task (the copper not being tinned) to melt the solder between the strips of brass. With a tinned soldering copper the operation is more easily performed. Take a large strip of solder on the copper, place it upon a strip of brass, press the hot copper into the solder and see how quickly the heat will be transmitted through the brass and melt the solder A flux acts in the same way to a great extent; thus a flux really has two or three offices—first, preventing oxidization; second, transmitting heat readily; and, third, seemingly lowering the melting point.

In soldering, we need only take into consideration the first two offices, namely, preventing oxidization and transmitting heat readily. A flux, therefore, must be selected for each

operation which can protect the metal to be soldered and the solder to be used, and which can also withstand and readily transmit the degree of heat necessary for soldering.

The Common Fluxes.

The fluxes most commonly used are borax, a mixture of cream of tartar, also crude tartar, salammoniac, saltpeter and common salt. Charcoal may be added to the list, also resin and certain heavy oils. A number of fluxes will be described in the chapters devoted to brazing and hard soldering.

Soldering Compounds.

Fluxes are sometimes made up of several ingredients, according to the experience or whim of the user. In this condition they are called soldering compound, soldering paste, soldering fat, etc. Several solders were described above and the fluxes which may be used with them. The compounds may be taken as additional to the fluxes there described.

Soldering Paste.

Chloride of tin is often used in soldering when mixed with starch or paste until it is about as thick as cream or vaseline. This mixture is freely daubed over the territory to be soldered and stays in place under certain conditions better than when used in liquid form. Some tinners prefer an oily substance instead of one made in the form of a paste. Such a compound is called a " soldering fat " and may be made by saturating one-fourth of a pound of water with salammoniac. The water will take on a yellow color and some salammoniac will remain undissolved in the

liquid. It is best to pulverize the salammoniac to make it dissolve more readily. Place the solution to one side for use later, then melt one pound of tallow and stir in an equal amount of olive oil, then add one-half pound of pulverized colophony, boiling several minutes to make sure the ingredients are mixed thoroughly. When nearly cold add the quarter pound of saturated water already prepared and the mixture is ready for use.

Action of Colophony.

This substance, which bears such a sonorous name, is nothing more nor less than plain resin, so when some one wants to sell you " Colophony Soldering Compound," you will know just what it is. Its action is similar to that of turpentine and even of the very volatile oil of turpentine, all of which act in the following manner: When heated to the temperature of melted solder, they decompose into hydrogen and carbon, it being understood that the carbon acts upon the dross or oxide formed on the joint to be soldered and wholly or partially reduces the oxide, thereby rendering soldering possible. Later experiments by Spencer seem to prove that hydrogen which is liberated at the same time the carbon is separated also acts as a reducing agent and takes care of a considerable amount of oxide which otherwise would prevent or interfere with the soldering operation. Beeswax is also a hydro-carbon, and in certain cases may be used instead of resin for a flux with soft solder.

Use of Soldering Fluids and Compounds.

In the making of soldering fluids, the tinsmith is often guided by whim or hearsay. He has used a certain soldering fluid, compound or flux, with excellent satisfaction

upon one kind of work and gets the idea that it works so well upon one job that it is equally applicable to all kinds of work. It is for this reason that we find so many widely different compounds and fluids used for the same operation, in various shops. In one shop they use acid (hydrochloric) for soldering brass. The writer never thinks of using an acid for brass if he can get hold of resin or a soldering compound made from that substance. It is in the hope that the tinsmith will "use his head" a little more than his memory, in the selection and use of fluxes and compounds, that the instructions relating to this portion of soldering are given at considerable length. The writer has drawn largely upon his own experience for this data and has also taken much from the successful practice of other mechanics.

Soldering Liquids.

Nearly every tinner has a soldering liquid or compound upon which he prides himself, hence the number of soldering liquids is legion. Most of them are good. Hydrochloric (muriatic) acid represents one type of soldering fluid; chloride of tin represents another variety and phosphoric acid seems to be the limit in the third direction. Hydrochloric acid acts by corroding or dissolving the oxide. This acid is used in the raw state when soldering zinc or galvanized iron. It is applied directly to the surface and the soldering copper passed over them while they are still wet with acid.

Chloride of Zinc.

This substance is perhaps the best known of soldering fluids. It is prepared by dissolving in hydrochloric acid all the zinc the acid will take up. There is, however, a

doubt in the minds of many mechanics as to the permanency of joints made with this fluid. Some people claim that the acid is not gotten rid of during the soldering operation and that corrosion will set in sooner or later and eventually destroy the soldering connection by eating away one or the other of the metals where they come in contact. It is claimed that this action, though sometimes slow, bound to take place and that the soldered joint fluxed with chloride of zinc, will, sooner or later, fall apart.

A Good Soldering Fluid.

The corrosive action of hydrochloric acid and chloride of zinc may be eliminated and a fluid that will not rust iron or steel may be prepared, as follows: The usual amount of hydrochloric acid with all the zinc dissolved in it which the acid will cut, is left standing in a suitable vessel with undissolved zinc in the fluid. After being sure that no more zinc will be consumed by the acid, pour off the clear portion of the fluid, filter it and to every three parts of the solution add one part of salammoniac spirits. When ready to use, dilute with soft water, rain water if possible, until it is at the strength which is known to work best. This fluid may be used for almost all soldering operations, and for tinning iron or steel.

Lactic Acid Soldering Fluid.

Still another substitute for zinc chloride and one which is non-corrosive to metal, is formed by dissolving in water one part of lactic acid and an equal part of glycerine.

Gaudin's Soldering Fluid.

Still another soldering fluid may be made by dissolving in spirits of wine some phosphoric acid and adding cryolite which has been reduced to a very fine powder.

Borax and Resin Soldering Fluids.

Borax, as well as resin, may be used for soldering in liquid form. When thus prepared they are usually found much more convenient than in the dry form. Ordinary borax may be dissolved in water and then applied to the work with a brush or a swab. Resin may be reduced to a solution by means of any liquid which will dissolve it. It is a peculiarity of most of the gums and resins that some are soluble in gasoline, others in alcohol, while but few can be dissolved by both liquids. Usually those which will dissolve in one are insoluble in the other. Resin thus dissolved may be kept in an air tight vessel and forms a very convenient flux for the reason that when applied by a brush or stick, in the fluid state, the solvent readily evaporates, leaving the resin adhering tightly to the metal to be soldered. This is particularly desirable when soldering tin roofs and other work exposed to the weather, where wind would blow loose resin away before the joints could be soldered.

Flux for Aluminum.

An easily handled flux for aluminum is sulphuric acid and tallow. The former is applied to the aluminum and dissolves the thin coating of oxide always found upon the surface of this metal. It is then coated with tallow,

but salammoniac is used in some soldering operations, which should be done with a freshly tinned copper.

Fluxes for Aluminum and Bronze.

A flux, which will enable aluminum and bronze to be soldered with ordinary soft solder, contains a strong solution of copper sulphate. Immerse the parts to be soldered in this solution, also put in a soft iron rod which must be made to touch both parts to be joined. This arrangement will cause a copperlike surface to appear on the bronze. The parts may then be removed from the bath, rinsed very clean and brightened where the solder is to adhere. When in this condition, the surfaces may be easily tinned by means of the ordinary zinc and muriatic acid solution, using common soft solder to unite the parts.

Coloring Soft Soldering Seams.

Sometimes on repair work, and also in some new work, it is desirable that soldered seams be colored to match the surfaces united. Quite a range of color can be obtained by the use of copper sulphate. This is the ordinary blue vitriol used by telegraph lines in their gravity batteries. A solution of this salt should be made by placing a small piece in a dish of water and stirring it until the water will take up no more of the sulphate. Paint the part to be colored with this solution either by means of a brush or a bit of cloth on a stick. While the coating is still wet, touch it with a bit of iron or steel when the surface will immediately become covered with a coating of metallic copper very thin and hard. By moistening several times and rubbing with a wire each time, the coating may be thus thickened until the desired color is obtained, provided the color can be matched by shades of copper color.

Where a yellow tinge is desired, a portion of the solution of sulphate of copper may be replaced by a solution of sulphate of zinc. Apply the mixture to the copper and touch with a zinc rod. By varying the proportions of these two solutions and the manner of applying also the manner of rubbing with iron and zinc, almost any shade may be obtained from solder white to deep copper color. Sometimes it is necessary to gild a soldered seam; when this is to be done, copper the surfaces as above directed, then coat with a solution of gum or fresh glue and scatter bronze powder upon the surface thus coated. If allowed to dry undisturbed, the bronze powder may then be polished.

CHAPTER IV.

SOLDERING FLUIDS.

Too much care cannot be taken in preparing both soldering fluids and soldering compounds. Dirty, sloppy preparations of these articles often result in a great deal of loss of time in their subsequent use. When making a soldering fluid in which chloride of zinc is the chief ingredient, place the acid in a clean vessel of glass or some substance not corroded by that liquid. Do not use an iron dish for making, keeping or storing either acid or zinc chloride. The tinner usually makes up from a pint to a quart of the solution at one time, but he must take care that the heat evolved during the mixing of the acid with the zinc does not crack the vessel in which the operation is performed. A good deal of heat is let loose during this chemical operation and the zinc is burned into ashes just as truly as if it were consumed in the smith's forge or in the tinner's fire pot.

Precautions Necessary in "Cutting" Zinc.

A one quart or two quart glass jar (such as is used for canning fruit) is a handy vessel for use in making soldering fluids. Pour the acid into the jar, then pour in about one-eighth to one-quarter as much pure water, or as pure as can be obtained. Rain water is excellent for this purpose, also condensed steam from a radiator. Don't put the water in the dish first and then pour in the acid;

this method may cause an accident as very strong acid, coming in contact with a little water in the dish, sometimes sets up a very lively disturbance.

Clean the Zinc.

Stir the solution either with a wooden stick or a zinc rod, but on no account stir with a piece of iron or steel. The mixture is now ready for the zinc, which should be clean. Do not put a lot of dirty zinc in acid when you are making soldering fluids. The zinc may be easily cleaned by dipping it into another dish of acid and then washing well before it is put into the dissolving dish. Good chloride of zinc can possibly be made from dirty, greasy zinc, but a better solution can be made from clean zinc, which carries no impurities on its surface.

Avoid Acid Fumes.

Do not put a large amount of zinc into the solution at one time. Drop it in, piece by piece; in this way you will avoid a sudden boiling or effervescence which may cause the solution to rise up in a mass of bubbles and overflow the dish in which it is being dissolved. The jar should be put in a large pan or set on the ground in such a way that should the jar crack from the heat developed inside of it, and the acid run out of the broken vessel, it will not run upon bench, tools or clothing. Better set the dish outside where the acid fumes will not be breathed by the workmen.

Stir the contents of the vessel occasionally, using a zinc rod or wooden stick in all cases for this purpose. Allow the zinc to remain in the solution until there is no further sign of any action between it and the acid. After all action

has ceased, add a little water to the solution and note if any bubbling takes place. If so the solution should be allowed to remain in contact with the zinc until all action has ceased.

Filtering the Zinc Chloride Solution.

When no more gas bubbles can be made to appear on the zinc, either by shaking, stirring or adding water to the solution, then it should be poured out of the jar into a filter which may be several thicknesses of cloth, filter paper or a bit of clean cotton waste tucked in the bottom of a funnel.

The zinc chloride solution is now ready to be stored until needed for use. It may be placed in another fruit jar, covered to keep out the dirt and set one side until needed, where it will not be mistaken by the workman for his coffee can, as it does not make a good beverage. When required for use, dilute with one or two parts water, as described elsewhere.

Testing Hydrochloric Acid.

There is a great difference in commercial acids as purchased for making zinc chloride. There are chemical tests which may be used by the tinner, but it is not always practicable or desirable to do so as it takes considerable time. The best way in selecting the acid is to put it up to your dealer to supply the quality required. Commercial muriatic or hydrochloric acid is nothing but a solution of gas in water. Pure hydrochloric acid is not a liquid but a dense gas which throws off heavy fumes when exposed to the air and the strength of the acid depends on the amount of this gas which has been absorbed by the quantity of water.

Use of the Hydrometer.

The acid may be tested by means of a hydrometer. This is a little instrument which is placed in a deep dish of the acid and a reading taken which shows the depth to which the instrument sinks in the acid. In pure water, the most of these instruments, the one known as Baumé's in particular, will sink to the zero mark. In acid which is heavier than water, the instrument will not sink as deeply and in the strongest acid known it will not go deeper than the 25 degree point. Water is so fond of hydrochloric acid gas that at 68 degrees Fahr. a quart of water will take up 460 quarts of this gas and the original amount of water will only be increased about one-third during the operation. Water at 32 degrees will not take up any acid without showing it on the hydrometer scale, but at 59 degrees 100 parts will take up one-tenth of one part of acid without showing it on the scale. At 10 degrees Baumé there will be 14 or 15 parts of gaseous acid in the water; at 20 degrees there will be 30 to 32 parts, and at 25, from 40 to 42 parts, all depending upon the temperature of the water.

A Home-Made Hydrometer.

The tinsmith may easily make a home-made instrument for testing acids. All he needs to do is to purchase from the nearest drug store two test tubes, for five or six cents each, one large enough to contain the other, as shown by Fig. 12. The large tube should be supported in an upright position. It may be placed in a hole bored in a block of wood, as shown in Fig. 12, or the tinsmith may, at his leisure, make a metal stand for supporting the instrument.

The smaller tube, A, should be loaded at the bottom, as shown at D, in such a manner that it will stand upright

when placed in water. The load may be of shot, pieces of solder or any convenient material. After the proper amount has been placed in the tube, which amount can be

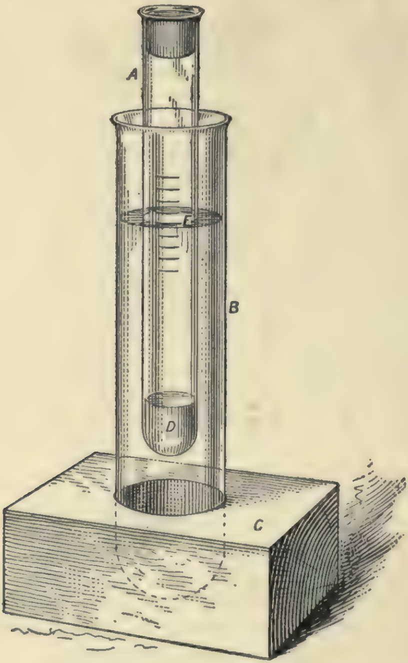


Fig. 12.—A Home-Made Hydrometer.

determined by filling in until the tube will stand upright in the water, fix the loading by means of calcined plaster. Next, fit a cork to the top of the tube, as shown at A, and seal up by melting resin over the top of the cork with a hot soldering copper.

Fill the large tube B with as pure water as can be obtained; fresh rain water will answer very well. Make a mark on tube A with a file, level with the surface of the water in tube B. The mark is shown at E. Whenever this instrument is placed in a substance as heavy as water and allowed to float, the liquid will always come even with mark E. When placed in a heavier than water liquid, mark E will be above the level and when placed in a liquid lighter than water mark E will be below the surface.

Calibrating the Hydrometer.

When acid is obtained, test it out by putting a portion of it in test tube B and note the level to which tube A sinks in the liquid. A number of marks may be scratched on tube A, equally distant from each other, as shown above and below E. These marks may be made any convenient distance, say one-sixteenth inch apart, or the druggist's hydrometer can be borrowed long enough to calibrate the newly constructed instrument. Whenever acid is tested, note to what degree mark E rises. Acid being heavier than water, E will be above the liquid. When more water is added to the acid, mark E will go down orrespondingly.

Selecting Acid by Hydrometer Test.

As stated before, water containing 100 parts of gaseous acid should show 25 degrees on the Baumé scale. If the home-made hydrometer is graduated to a "store" instrument it will be just as easily read as the druggists, but the temperature of the acid must be noted. When making tests for an acid showing 7 degrees on the hydrometer, it contains 9.9 parts acid at 32 degrees F. and 10.4 parts acid at 59 degrees. Simply note the number of degrees of

a good working acid and when purchasing a supply of that fluid accept, reject and pay according to the strength shown by the home-made hydrometer. It may be added that this instrument should be kept clean at all times and it is well to keep it in test tube B, which may be filled with water and tube A placed in it when not in use.

Making Soldering Compounds.

When making up soldering compounds, means should be provided for pulverizing certain of the ingredients and pulverizing should be as thorough as possible. A compound which contains chunks of resin or salammoniac is not desirable. Either mix them thoroughly by grinding or else dissolve them in suitable liquids, then mix together thoroughly and drive off the liquid by evaporating or distilling.

It may seem like quite a problem for a tinner to combine ten pounds of resin with a pound of salammoniac and as much more zinc oxide without having the mixture full of lumps. This may be done, however, and there are several ways of doing it. The resin may be pounded and sifted through a piece of muslin or other thin cloth. The best way of doing this is to place the resin in a mortar or iron pot, pound with a wooden pestle or maul until there is considerable fine material in the resin. Then place over a sieve of about one-sixteenth inch mesh and what goes through may be shaken on a finer sieve. The coarse sieve is to prevent loading the fine muslin with coarse particles.

Pulverizing by Chemical Methods.

All the resin rejected by the sieve must go back and be pounded again, so continuing until a sufficient quantity has been passed through the muslin. Proceed in the same manner with the salammoniac. In some cases it pays to

work them together. The tinner must determine this for himself. If he desires to experiment a little, he can try chemical means of pulverizing. By dissolving resin in gasoline or wood alcohol he can reduce it to particles finer than can be separated with any sieve. Salammoniac may be reduced in a similar manner with water.

These two solutions may be combined, thoroughly mixed and emulsified by means of a third substance, which will cause the two to unite. Soda will do this, common bicarbonate or cooking soda. The tinner may find other substances which will do the emulsifying and, at the same time, add to the fluxing qualities of the compound.

Resin Soap.

The mixture of salammoniac, resin and soda makes a form of soap which may be dried and pulverized or used moist in paste form. After drying, it may be mixed with oil and used as an oil paste which has the advantage of not drying out as water paste will. The finished compound should be stored in vessels which will keep it free from dirt and prevent waste. Too often the tinner is led to make up a whole lot of soldering compound and then leave it exposed in a bucket or keg for dirt to get into or for his men to waste by careless usage. Put the compound in small vessels, close them tightly and fasten on the covers and the compound will remain in good condition until needed for use. Never leave soldering compounds or fluids standing around in open vessels, except those which are actually in use on the bench.

Silver Soldering.

Silver soldering is often termed hard soldering and the two terms mean about the same thing. The distinguishing

or dividing line between hard solder and soft solder may be taken that any solder which requires a red heat to melt it is classed in the hard or silver class. Solders which melt below a red heat are termed soft.

Strength of Soldered Joints.

In almost every instance a hard solder joint is stronger than one made from soft solder. The difference is due to the hardness of the solder used, silver and copper alloys, of course, having greater strength than those of lead and tin. The writer has not at hand tables giving the strength of various alloys, therefore their strength must be judged by their composition, and it goes without saying that the more copper and zinc contained in the solders, the stronger they will be, whereas the more tin is mixed in, the softer will be the alloy, the more readily fusible it will be and the less strength it will give to the soldered joint.

Silver Solders—When Used.

The silver solders are not used where any other alloy can be made to answer. The solders made from copper, zinc and tin are really hard solders and should not be classed with the silver solders; there is really no dividing line between the two unless indeed it be drawn between solders containing silver and those containing none.

Solders for Gold.

Taking the position noted in the preceding paragraph, we may well commence at the top of the list and tell about hard gold solder as well as the hard silver solders. Silver solders contain silver, copper and zinc or brass; the gold solders contain gold, silver, copper and some of them con-

tain zinc. One or two of them contain neither silver nor zinc, being made of gold and copper only. The more gold contained in silver solder the harder it will be to fuse the alloy, and the greater the strength of the joint will be. One of the best solders used is made of gold four parts, and silver one part. A solder which fuses easily is made of gold ten parts, silver three parts, and copper one part. The true silver solders vary greatly according to the work upon which they are to be used.

Hard Silver Solders.

Hard silver solders are commonly divided into two classes. The first class is what is known as "for first soldering." Several grades of solder are necessary, as stated, and the following table gives them in the order of their hardness, thus I, II, III, etc., in the table devoted to the hardness of solder, which decreases as the numbers increase, I being the strongest:

HARD SILVER SOLDERS FOR FIRST SOLDERING.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
					Parts.						
Fine silver	4	2	19	57	66.7	66.3	50	11	16	6	9
Copper	.	.	1	28.6	23.3	25.7	33.4	..	..	..	....
Brass	3	1	10	....	....	....	....	4	15	76	15.7
Zinc	.	.	5	14.3	10	11	16.6	1	1	18	35

Softer Silver Solders.

In the manufacture of silver ware it is frequently necessary to solder parts together and then perform other soldering operations to unite additional parts, for which a solder must be used which will melt without fusing the first soldering. For this purpose soft silver solders are

used, known as Softer Hard Silver Solder for After Soldering. The following table gives the ingredients in nine of these solders, the first one being the harder and the last one being the softer and more fusible.

SILVER SOLDERS FOR AFTER SOLDERING.

	I	II	III	IV	V	VI	VII	VIII	IX
					Parts.				
Medium fine silver......	7	16	16	3.5	2	10.5	68.8	67.1	48.3
Zinc	1	1	1	1	1	3	8.2	10.5	16.1
Copper	.	..	..	2.6	3	4.5	2.3	24.4	32.3
Tin	.	..	..	...	.	....	....	....	3.3

Methods of Silver Soldering.

Silver soldering is performed in almost ever; instance by means of the blow pipe. Sometimes a modification is used which may be operated by compressed air and in some kinds of silver manufacturing where large soldering operations are to be performed, gas furnaces are used, arranged almost exactly like the furnaces which will be hereinafter described in the chapters on brazing. The descriptions here given will therefore be confined, almost entirely, to silver soldering with the blow pipe.

Soldering with the Blow Pipe.

Blow pipe soldering may be roughly divided into two processes, the first of which consists of placing finely divided silver solder in the form of thin sheets or filings, between the parts to be united. Apply heat until the solder melts; the parts are forced together by pressure from a pair of pliers, tongs or a vise, until the objects are brought into contact in the position they are to occupy after the soldering is completed.

The other method is where the objects are fitted and fastened together by means of iron wire, rivets or clamps;

then the fluxes and solders are applied to the outer surfaces before the soldering or heating operation is commenced. Thus in one method, the solder, in thin sheets or filings is placed between the parts to be united which, after heating, are pressed together and the surplus solder squeezed out, almost exactly as when a glue joint is made. In fact this operation may well be called "gluing with the blow pipe." The second method of hard soldering, that of uniting the fitted and fastened parts, is almost exactly like the methods of brazing which are in common use and which will be described elsewhere.

The Blow Pipe.

A form of mouth blow pipe was described and illustrated by Fig. 11 on page 31, together with the peculiarities and value of the different portions of a blow pipe flame.

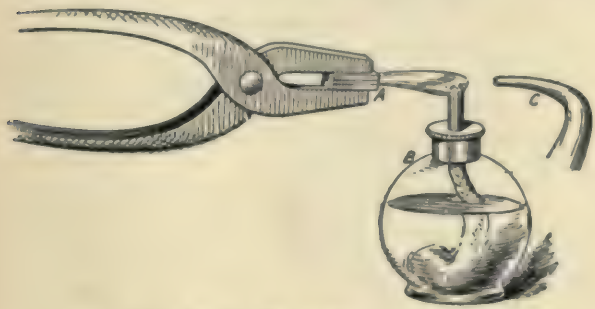


Fig. 13.—Blow Pipe Squeeze Soldering.

Fig. 13 illustrates the first method of blow pipe "squeeze" soldering. A couple of small plates which are to be joined together are shown at A, being held in a pair of pliers.

The flux and finely divided solder have been placed between the plates and the alcohol lamp, B, has been placed in position so that a jet of air from blow pipe C will cause the flame to impinge upon the work to be heated. Of course if gas is used the lamp B will be replaced by the gas jet.

The entire operation is very simple, in this case the plates A being heated until the solder between them melts; the plates are then squeezed closely together by pressure upon the pliers, after which the pressure is maintained a few seconds until the solder cools enough so that the plates

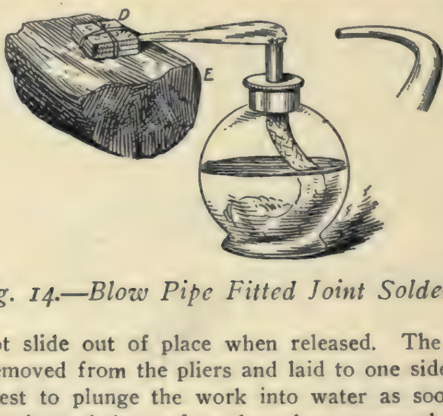


Fig. 14.—Blow Pipe Fitted Joint Soldering.

will not slide out of place when released. The work is then removed from the pliers and laid to one side to cool. It is best to plunge the work into water as soon as the solder melts and the surfaces have been squeezed together.

Blow Pipe, Fitted Joint Soldering.

Fig. 14 illustrates the fitted joint method and the plates shown at D. It will be noted that they have been brought into contact with each other and tied together by means of some fine iron wire. Some bits of solder may also be noted on the top of the plates which rest upon a piece of

charcoal E, and which becomes incandescent, greatly hastening the soldering operation by preventing air from cooling the work while being heated by the blow pipe, the operation of which is exactly the same as shown by Fig. 13.

The work-on-charcoal method shown by Fig. 14, is a duplication of the furnace method of soldering with the gasoline blow torch, described in connection with Fig. 9 on page 26.

Further description of blow pipe soldering is unnecessary as the tinner who has much of this work to do will be able to take it up readily from the descriptions above given.

A Gas Blow Pipe.

The mouth blow pipe is suitable for very small work, but where joints are to be soft soldered by means of the blowpipe, one fitted to use gas and air should be provided. Such a device is shown by Fig. 15 and consists of two tubes which are so brought together that tube A, which carries a supply of compressed air, passes inside of tube B, which carries gas; they unite in tube C, and, the amount of gas and air being controlled by means of valves, one of which is placed in pipe A, another in pipe B.

The moving of these valves, by the workman's finger, during the soldering operation, regulates to a nicety the amount and proportion of gas and air to the extent that a little flame, one-half inch long, or a big flame, 6" or 8" long, may be delivered from the same blowpipe, with no change whatever except the movement of the valves by means of the finger.

Rubber tubes are attached to tubes A and B at D and E, respectively. Tube E is connected to an ordinary gas burner, the tip being removed, or it may be attached to the gas supply by means of a special connection. When

no gas service exists in the tinner's locality, he may use acetylene gas, or he may set up a little gasoline generator and use gas therefrom. The whole supply may be maintained under slight pressure by means of a blower. The air pump and blacksmith's blower will supply air enough

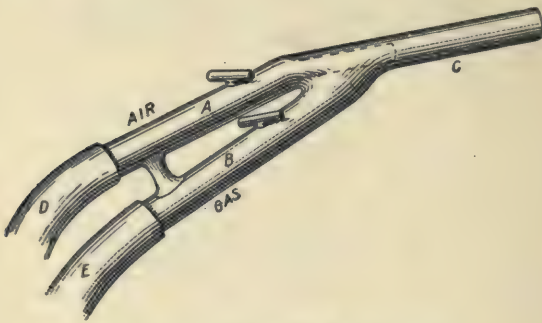


Fig. 15.—Air-Gas Blow Pipe.

to do a fair job of soldering with this form of blowpipe. It is used almost exactly as the mouth blowpipe described above.

Home-Made Gasoline Blow Pipe.

As stated above, gasoline vapor may be used with this form of blow pipe when illuminating gas is not to be had. A device for using gasoline may be quite easily rigged up. An air pump of the bicycle type will answer, but of course a power pump is better. Procure a range boiler, as shown by Fig. 16. One of the short boilers may be used, but a full size is preferable, as it contains more air capacity and need not be pumped up nearly as often. Close all the openings in this boiler, preferably by soldering, but screw plugs

may be used if found necessary. The boiler is shown as lying upon its side, while the air pump is connected at B. It will be better to use a power driven pump, but a foot pump may be made to do the work if necessary.

Connect pump to one of the openings in the boiler and place check and stop valves in the connecting pipe, to make sure of retaining what air is pumped in. These valves are shown at C and D, respectively. Attach a hose to the other opening in the boiler head, to which a stop valve has already been connected, as shown at E. To this hose

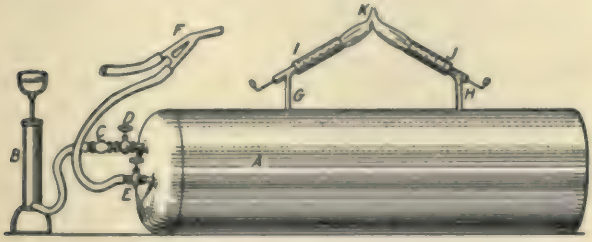


Fig 16.—Gasoline Blow Pipe Arrangement.

attach the gas supply tube of the blow pipe, shown at Fig. 15. The air tube of this instrument may be supplied and connected as described in connection with Fig. 15. This blowpipe is shown at F, Fig. 16.

By attaching to the boiler two vertical tubes, G and H, a very convenient arrangement may be made by the use of two blow torch tubes, I and J. These torches are swiveled, so as to turn in any direction, and they may be lighted up the same as though they were supplied with gas. When turned so that the flames meet at K a very high temperature will be formed, capable of melting brass when placed in the angle between both flames. This is a very

convenient tool and will be found to pay for itself in a very short time.

By placing a flat table on the top of boiler A, and letting pipes G and H pass through the table top, a very handy soldering arrangement will be the result. By piling some bricks between G and H and placing a handful of charcoal on top of the bricks, torches I and J may be turned on and ignited, when the whole arrangement will form a very good substitute for a smith's forge, as the charcoal lasts.

CHAPTER V.

SOLDERING OPERATIONS.

Fluxes for Silver Soldering.

There is no universal flux for use by mechanics who do silver soldering, but the one which comes the closest to being universal is, beyond doubt, good, clean borax. In fact borax is the foundation of about all the fluxes used in hard soldering. The following fluxes may be used upon silver objects and all that are to be silver soldered: Mix one part of borax with one part, by weight, of washing potash. When melted together and thoroughly mixed, place it to cool and pound it into powder, and apply some of this flux to the work before heating. The flux will protect the surface of the work from oxide and it will also reduce some of the existing oxide, provided all conditions are right. This flux may be moistened with water and used in the form of a paste or it may be used dry in a pulverized form, as found most convenient.

Another good flux for blowpipe work is boracic acid, 41½ parts; common salt, 35 parts; ferrocyanide of potash (yellow prussiate of potash), 20 parts; resin, 8 parts, and carbonate of soda, 4 parts. The above mixture makes a fine flux, but it will not keep very well; it should be made and used fresh. If an attempt be made to keep the mixture any length of time it will be found to gradually decompose, which may be known by its turning a blue color.

Another flux which is good for certain hard soldering

operations consists of flowers of sulphur, one part, sal-ammoniac, three parts, and borax, ten parts.

Boracic Acid Fluxes.

A very fine flux for almost all kinds of hard solder consists of boracic acid. This comes in powdered form and looks like cooking soda. This salt may also be used for brazing and will be described in the chapters devoted to that method of joining copper and iron parts.

Method of Applying Fluxes to Silver Soldering.

Fluxes for silver soldering are usually made in powdered form and may be applied to the work by means of a small piece of metal shaped like a paddle or spatula. Some workmen use a bunch of bristles formed into a bit of tin for a handle. A bunch of fine brass wire may be held in a scrap of tin in the same way and proves most excellent for applying flux. The ordinary mucilage brush is an example of this method of holding bristles in a tin handle so they may be used as a brush.

When Flux Should Be Applied.

The flux should be applied as early in the game as possible. Where there is a flat surface, put some of the flux upon it before beginning to heat the object. When it is a cylindrical article which will not hold flux to advantage, it must be heated slightly before the flux is applied. When hot enough to melt the flux, that substance will adhere to the work until it melts and spreads itself over the surface thereof. Hard solder may be applied in the same way, but some means must be used, depending upon the ingenuity of the workman, to keep both flux and solder in contact with the exact spot to be reached by them after they melt. More poor soldering and poor brazing is caused

by poor application of flux than by any other means. If flux does not reach the parts to be soldered, it is quite likely, in fact almost sure, that the solder melts and runs to some other place than that which requires soldering.

But if the flux be applied and held upon the joint where the solder should go then there will be little trouble in getting a good joint. Fine iron wire may be wound around the object to be soldered to hold both the solder and the flux. When there is trouble in keeping hard solder flux where it belongs, a little powdered resin may be sprinkled upon the object and then heated. The resin melts quickly and if the hard solder flux be sprinkled upon the melted resin the flux will adhere and probably give no further trouble by slipping out of place. The resin is driven off by heat before the borax and other substances in the hard solder flux become melted, therefore the resin acts merely as a cement to hold the borax and hard solder in place until they, too, become sufficiently heated to adhere to the work.

Finishing a Hard Solder Joint.

If a hard solder joint be removed from the fire and allowed to cool as soon as the solder runs, there will be found many lumps and streaks of solder adhering to the joint which present an unsightly appearance and which must be filed and ground away in order to finish the work so it will present an acceptable appearance. When the joint is firmly held in a temporary manner by means of a rivet, a dovetail or by binding wire, the surplus hard solder should be removed before the joint cools. A little piece of stiff wire, shaped like the household stove poker, answers admirably for this purpose; a little piece of metal, or an old knife with a point, may also be used.

As soon as the hard solder runs, remove the work from the furnace, cut off the blow pipe flame and immediately

proceed to scrape the joint with the piece of metal in question. This must be quickly done as the hard solder cools very fast. It may be necessary to continue the heat for several seconds while the first of the scraping is being done, but hard solder cannot be scraped off readily when it is in an exceedingly fluid condition when it first melts and runs into the joint. There is a time after the hard solder begins to cool when it is paste like and behaves much like solder used in a wiped joint. This is the instant when the cleaning should be done, and by the dexterous use of the scraper, which is described above, nearly every particle of surplus solder may be removed from the work, leaving it smooth and clean and requiring only slight sand-papering or brushing to fit it for the customer.

Proving the Work.

Concluding the discussion in our last chapter, it is always well to prove a soldered joint, especially when there is any doubt that the joint may not be perfect. In original soldering, during manufacturing operations, there is little necessity for proving joints, but in repair work they should always be tested. This may be done by slight bending of the joints or by jarring it by means of a small hammer. If it be small work, pressure by the fingers, tending to break the joint, will be sufficient. If there be a weakness in the soldered joint, it will usually develop itself under this treatment so as to be readily detected. Such defects are usually caused by the surface of one or both of the parts to be united not having been properly cleaned. Perhaps the oxide was not sufficiently removed and the hard solder, instead of uniting perfectly, with both bodies, simply attached itself to one of them and flowed over the other, presenting the appearance of a good joint, while in fact it was very poor indeed and would come apart at the slightest jar or strain.

Using Soldering Coppers.

The actual operation of soldering is one of the simplest things imaginable; in fact it is simplicity itself, but, like many other mechanical operations, it is not in itself a single great thing, but it is made up of ver many small things and the neglect of these may seriously impair the value of the operation. While the omission of a single detail may not injure the work, to any extent, neglect to carry out several of the details will be very noticeable in the condition and appearance of the work.

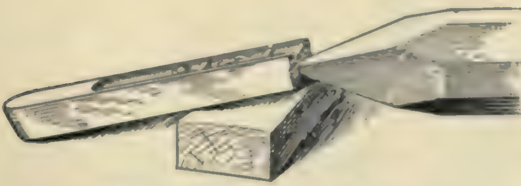


Fig. 17.—Taking Solder.

About the first thing in performing a plain, soldering operation, after the application of the flux to the prepared joint, is to take up some solder with the copper. Fig. 17 illustrates the usual method of taking solder. A stick of "half and half" is placed so that one end is resting on a bit of wood, a cold chisel or some similar object and the heated copper is pressed down upon the solder, as shown. A small globule of the solder is melted and adheres to and is taken up by the copper when it is removed. When a copper will not take up solder readily it is a sure indication that the copper needs tinning.

To perform the simple operation of soldering two flat pieces together, lay one upon the other, as shown by Fig. 18. Dust a little powdered borax or soldering compound

upon the joint as shown at A, then press the joint together with an awl or the tang of a file, as illustrated at B. This tool may be held by the left hand while the copper is manipulated with the right. If the pieces of tin lie perfectly smooth and flat, the awl B may not be required, but in nine cases out of ten it will be found necessary.

Next take up a little solder, as shown by Fig. 17, then place the copper on the joint, as shown at C, Fig. 18, and draw the copper along the seam. The movement must not be any faster than will allow the solder to melt and spread

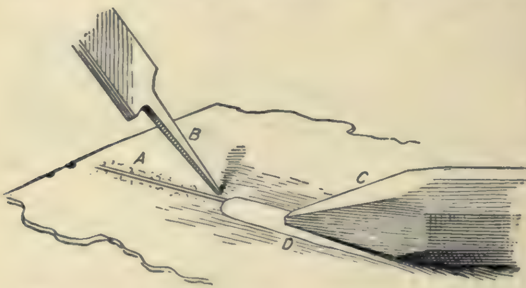


Fig. 18.—Running a Plain Seam.

itself along the seam. If the copper be drawn too fast, the seam will present an uneven and bulging appearance, while if the copper be moved too slowly, the solder will melt and spread itself over a large area on either side of the joint. With the work properly fluxed, the solder will flow readily and unite smoothly with both of the edges to be soldered, as shown at D. The copper can be moved along at a considerable rate of speed. Some simple seams, on long work, have been soldered at the rate of over 200 linear feet per minute, while other seams can not be soldered faster than one foot per minute.

Speed of Soldering.

The speed at which seams can be soldered, "run," as the workman terms it, depends upon the weight of the metal to be united, the kind of metal and the condition of its surface. Heavy metal requires more time, for the surface to be soldered must be raised to the temperature of melted solder, or nearly to that point; therefore, when soldering very thin tin with a heavy copper, the metal can be heated quickly and the rate of speed mentioned in the preceding paragraph is not impossible.

On the other hand, when soldering metal say 16 to 20 gage, considerable time is required for heat to be transmitted from the copper to the metal, hence more time is necessary for soldering heavy seams. The position of the copper also governs the speed of soldering and is governed, in turn, by the thickness of metal being soldered. In Fig. 19, which illustrates this point, a copper is shown in three positions. In the first it is laid flat upon the seam, the entire length of bevel from A to B bearing flatly upon the work. This gives a long body of metal from which heat may be transmitted to the work. This position of the copper should be used when heavy seams are to be

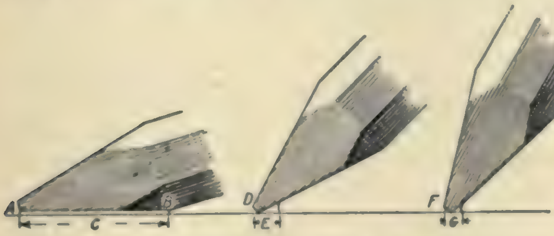


Fig. 19.—Speed of Soldering.

run. Of course a heavy copper must be used and the longer the bevel, the better and quicker will the work be performed.

The smith will see from this the importance of giving a long bevel to the copper with which he is going to run heavy seams and in the light of this knowledge, the enterprising workman will not be found with short, stumpy bevels on his coppers.

Where the copper is laid flat from A to B, it will be noted that there is a film of solder between the copper and the work, extending the length of C. When thinner metal is to be soldered, the workman will "raise his hand" until only the point of the copper bears upon the work, as shown at D. This necessarily shortens the film of solder between the copper and the work, until it is not longer than shown at E.

The length of film E. of course, depends upon capillary attraction, that property of all fluids, no matter whether water or metal, which causes it to climb up the side of a small opening or cavity. Less heat can be transmitted at the same speed of movement of the copper when only length E of film connects copper to work, than when length C makes a connection. At F, the copper is shown inclined at a still greater angle with the work and the film of solder is shortened to G, which is about as short as it is possible to make it.

The experienced tinner makes use of this peculiarity in the behavior of soldering coppers, but he does it almost, if not quite unconsciously. When he first takes a copper from the fire, he will hold it a few inches from his cheek, in order to judge the degree of heat to which it has attained.

Judging Heat of a Copper.

A very little practice in the direction noted above will enable a man to judge very closely the degree of heat in the copper and he knows almost instinctively whether it is hot enough to do the work in hand or whether it should be returned to the firepot for further heating. As stated above, when applying a freshly heated copper to the work in hand, the tinner places it in the position shown at F, and he does this without thinking why it is necessary. Then as the soldering proceeds and the iron grows cooler, he will have it approximate the condition shown at D; finally, when he returns the copper to the firepot for the reason that it will not melt the solder fast enough, he has been using it in the position shown at C.

Soldering with the Corner of a Tool.

There is another way in which a smith varies the position of a tool according to its contained heat, and the

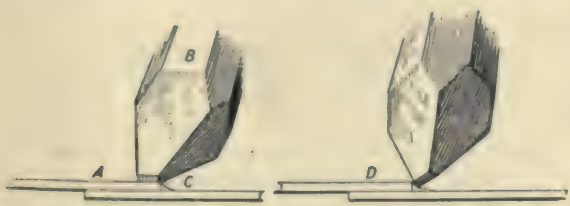


Fig. 20.—Soldering with a Corner of the Copper.

character of the work being done. Looking squarely towards the copper from the end of the seam which we show at A, Fig. 20, the copper will be in the position of the one shown at B, the flat bevel bearing squarely upon

the lap of the seam and the film of the solder forming a corner, as shown at C, and extending also between the sheets of metal to a considerable distance. This position the tool usually takes when soldering light seams at considerable speed.

When heavy metals are to be used, the tool sometimes takes the position shown at D, the corner of the tool being run along in the angle made by the end of one plate and the side of another.

When the tool is given this position, the heat is confined almost entirely to the angle in the sheets above mentioned and extends much less towards D than when the tool is laid flat upon the surface, consequently the soldering will not be as good, the joint will not be as permanent. This form of holding the tool should only be resorted to in repair work, in some special jobs where the whole requirement is to obtain a soldered joint under adverse circumstances and the motto is "to get there and get there quick," no matter whether the joint lasts a week or a month. For new work and shop work in particular, never use this method of applying a copper to the seam.

Soldering Very Light Seams.

As stated, there are cases where it may be necessary to use the corner of a copper. This is especially true on repair work and where long and very light seams have to be soldered. Fig. 21 shows two methods which may be employed and a corner of the copper is used in both. The copper shown at A is placed so that the narrow edge of the tool presses against the edge of one of the sheets to be soldered. It is evident that in soldering joints with a tool of this kind, it must be upon the surface only, so to speak, and it cannot cause the solder to run under a sheet to any great extent.

The method of soldering, shown at A, will work on very thin lead sheets, also on very thin tin sheets, and it may also be used on soldering Brittania ware. As only the point of the tool or one corner thereof can bear upon the work it is evident that no great quantity of heat can be transmitted to the work, therefore there is little

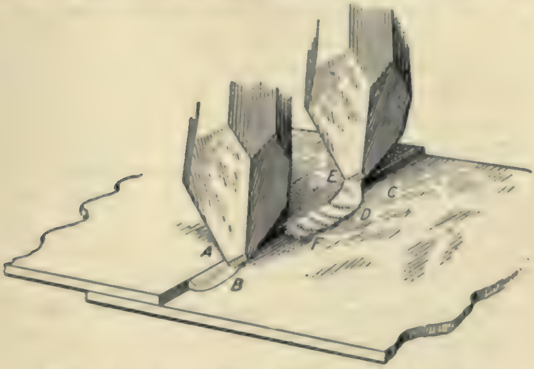


Fig. 21.—Soldering Very Light Seams.

danger of melting holes in the lead or tin which is being united. Note the manner in which the solder at B has been shaped into a corner; it looks almost as though a piece of wax had been melted and rubbed into the angle.

Soldering Fusible Substances.

In cases where very fusible alloys must be united with solder, the manner shown at C, Fig. 21, may be used. It will be noted that here the copper is held at a distance above the work, which it does not touch, the section of soldered work being as shown in the series of waves or small hummocks. The copper is charged with solder in the

manner shown by Fig. 17, then it is touched to plate D, and afterward immediately withdrawn to the position shown at E. It is now evident that all the heat transmitted from E to D must pass from one corner of the copper and through the globule of melted solder.

When copper E can only impart its heat to D, through the film or globule of solder, the joint may be closed as shown, by dropping upon it a succession of drops of solder, as shown at F. This makes a seam which closely resembles one made by a lead burner and but little heat is transmitted to plate D during the operation. In fact this method is practically opposite to the method shown by Fig. 20, at B. A modification of this method may be employed in soldering vertical seams, which will be described later.

Running Long Seams.

The tinner never solders a seam; he "runs" it. Only when talking with an inexperienced person will he mention

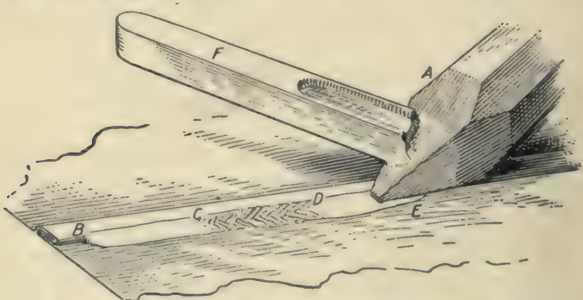


Fig. 22.—Running a Long Seam.

soldering. The application of solder to a long seam and obtaining a smooth, even flow of the same is simplicity in itself, to the man who knows how. Fig. 22 shows how

to do the work properly, also how not to do it. The proper position of the copper is shown at A, with one of the bevels lying flat upon the seam as already described and illustrated by Fig. 20. From B to C, it will be noted that the seam is smooth and of even width; there is no ripple or wrinkle in it. In the narrow seam, were it not for the difference in color between the solder and the plate, it would be almost impossible to detect with the eye, where the seam commences and where it leaves off. In the engraving it is only possible to indicate the edges of the seam by means of lines. To make a seam which looks like this, the copper must be clean and well tinned and hot, but not too hot. If the film of solder on the copper is hot enough to show colors, then it is being oxidized very fast and will soon burn off. A copper is too hot when colors appear, as stated.

Conditions Necessary for Good Soldering.

To obtain a seam similar to that shown at B, C, three things are necessary. First, the condition of the copper, as described above. Next, the copper must be moved along the seam at a proper and uniform rate. Third, the solder must be applied evenly and regularly to the copper. When these conditions are fully complied with, the length of seam which can be run will be limited only by the amount of heat contained in the copper used in melting solder into seam B, C. To obtain a seam of this description the copper should be passed over the surface only once. A seam should be commenced, made and finished, complete, during a single passage of the copper over its length.

Effect of a Cold Soldering Copper.

When the copper begins to cool, the seam may present the appearance shown between C and D, which closely

resembles a piece of torn up brick pavement. The beginner in soldering will have no trouble in running such a seam. It is done by using a copper which is too cool and pushing the copper back and forth many times, each forward and backward movement forming one of the ridges shown in that portion of the seam.

After a nice piece of seam has been run, like B and C, and the workman finds the seam begins to take the appearance of the one between C and D, he knows it is time to change the copper or reheat the one which he is using. The section of seam between D and E, Fig. 22, shows the effect of the reheated copper. This section of seam looks as well as that between B and C, but no matter how the remainder of the seam may look, the portion C and D is an eyesore, and it will be found a very hard and difficult operation to make this portion of the seam look like the rest, hence the necessity for making and finishing a seam at one operation, that is, by a single passage of the soldering copper.

Patching a Seam.

But a seam like that show at C, D must be patched up in some manner so as to look half way decent, at least. A method of making a smooth stop in a seam is shown by Fig. 23. This method is useful, not only when patching up a seam like C, D, Fig. 22, but also when a smooth seam like A, B, Fig. 23, has been run to the limit of the heat contained in the copper. This necessitates a stop in the seam and the problem is to connect on that portion of the seam run by the reheated copper without forming a bunch of herring bones like that shown at B.

As stated, the disfigurement at B was made by joining a new portion of the seam to one already made and cool. Several short movements of the copper were made in a vain attempt to make it smooth and even. It is safe to

say that the seam can not be joined smoothly by any back and forth movement of a heated copper. The proper manner in which to make a stop joint of this kind is herewith described, and the finished joint will present the appearance shown, where B, C is the old seam and C, D the new seam.

It will be noted that at C there is no roughness and the only thing discernible in the joint is a slight difference in the color, shown at C. This stop joint is made by placing the hot copper flat and squarely upon the end of the

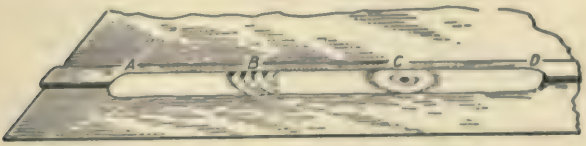


Fig. 23.—Making a Smooth Stop in a Seam.

seam then letting it remain there without moving, in the least, until the whole portion of the joint is thoroughly and completely melted. When this is accomplished and the solder is melted for the same distance towards B and towards D, then the copper can be moved along in the manner described for running a seam, when it will be almost impossible to tell where the stop was made except for the slight discoloration.

Applying Solder.

It was stated above that one of the conditions for running a smooth seam is the even and regular application of solder. This is a very important matter and one which the young tinner will have trouble with before he gets the knack of it. A good method of applying solder when running long seams, is shown by Fig. 22, where A shows

the copper running the seam, F a stick of solder, and shows also the manner of application to copper A. The application should be at short and even intervals and the solder must not be left in contact with the copper too long at a time, as too much solder will be melted and the joint will be found heavy and irregular in size, being too large where much metal is run in and too small where the supply of solder was deficient. The stick of solder, F, Fig. 22, should be held in the left hand and it should be touched to the soldering copper at frequent and regular intervals.

CHAPTER VI.

DIFFICULT OPERATIONS IN SOLDERING.

Soldering a vertical seam is neither a pleasant nor profitable operation and the tinner will not do it from choice, neither is he expected to do it except in case of absolute necessity. Emergency repairs furnish the only possible excuse for soldering vertical seams; even then it pays to go to a good deal of trouble and some expense, if thereby soldering a vertical seam can be avoided. But when it comes to a showdown and a vertical seam must be soldered, two courses are open to the tinsmith. He may commence at the bottom and manage to make a bit of solder stick to the joint, as shown at A, Fig. 24. It will require quite a little juggling to do this, but once it is accomplished, the hardest of the work is done.

The next step is merely to deposit another drop of solder on top of the one shown at A, taking care that the soldering copper thoroughly melts the upper surface of the solder already in place, also that it heats the vertical surface to which the solder is to be attached. This work must be done with the point of the tool and with one corner of the point, as shown at A, Fig. 21 and when the drop of solder is deposited on top of the preceding drop, heating can be done as shown at E, Fig. 21. It requires a little time for heat to travel from the copper to the work, when the copper is used, as shown at E.

Having deposited the second drop of solder, proceed to heat another bit of the seam immediately above the second

drop and when solder from the copper will adhere to the heated portion, carefully run in another drop and thus add another section to the soldered portion of the seam. Proceed in this way and the seam will eventually have the appearance of several drops or ridges joined closely together, as shown at B of Fig. 24. Each of the ridges indicates where a drop of solder was worked into place. Continue

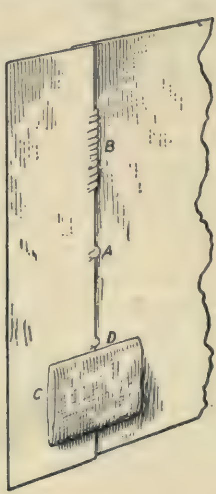


Fig. 24.—Soldering a Vertical Seam.

in this way along the entire length of seam, taking care that no pin holes are left in it, something which is very easy to do and which proves most aggravating when it comes to testing and making the seam tight.

Another way of soldering a vertical seam is shown at C. A bit of cloth is folded into a pad which is applied to the seam, as shown. Into the corner formed by the cloth and

the surface to be soldered, drop a globule of solder, as shown at D. The cloth will prevent the solder from running out of the seam, and it is very easy to follow up with the cloth as fast as the solder is worked upward. This is an easy way of soldering a vertical seam, but it is not a very scientific one, neither does it leave as handsome a seam as that shown at B. The cloth may be made into a pad similar to that used by plumbers for wiping a pipe joint. One of the real pipe pads will be found convenient and will answer every purpose. The pad should be daubed with tallow and the portions which are likely to come in contact with the heated solder may be sprinkled with powdered resin.

Scraping a Seam.

When doing some kinds of work, repair work especially, the surface of the metal must be scraped clean before soldering can be done with any assurance of making a good job. This is necessary when the surface is at all rusty or when, as in the case of tin roofs, a coat of paint has been applied and the tin has rusted through the paint. A tool for this work is shown at E, Fig. 25. For the surface immediately adjoining the seam the flat or outside edge of the scraper should be used, as it is necessary that the entire surface over which the solder is to be spread should be scraped clean and made free from paint or oxide.

A section of perfectly scraped surface is shown at A and B. At C and D is represented a portion of surface which has not been properly scraped. It will be noted that the scraped surface contains streaks and lanes of metal which have not been touched by the scraper. It will also be noted, from a close inspection of the surface between C and D, that not only are there streaks and lanes of unscraped metal, but the portions which have been scraped

proved to be filled with a crosswise section of surface which has not been touched. These crosswise parts are shown between C and D. They are caused by chattering of the scraper. That tool, instead of moving smoothly and evenly across the metal, jumps from one portion to another, leaving minute ridges, somewhat resembling teeth of a file. To avoid chattering and its subsequent results, as above stated, the scraper should be turned slightly side-

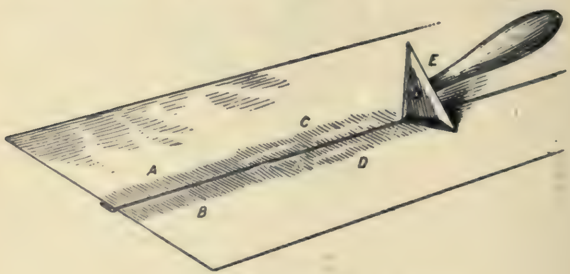


Fig. 25.—Scraping a Seam.

wise, as represented at E, and in that position it should be drawn along the surface under considerable pressure. It is quite a trick to use a scraper under considerable pressure. It is quite a trick to use a scraper and produce a clean, smooth surface without leaving any strips of unscraped metal.

The Scratch Brush.

Sometimes considerable help may be given to the scraping operation described by the free use of a scratch brush. A tool of this description is represented by Fig. 26. The tool consists of a block of wood in which are inserted, in the manner usual to brushes, fine steel wires instead of

bristles. Many varieties of wire are used for the purpose, according to the work for which they are intended. For scraping a surface to be soldered, the tinner should procure a brush about 2 by 3 inches, with teeth projecting from 2 to 2½ inches and made of fine steel strips of about No. 22 gauge and one-sixteenth inch wide. A brush of this kind, if used with plenty of elbow grease, will brighten

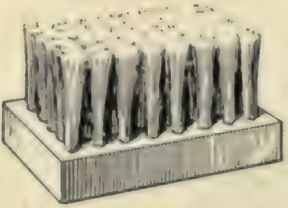


Fig. 26.—Brass Wire Scratch Brush.

the surface to be soldered very effectually, and in some cases it is advantageous to use a scraper in connection with the scratch brush. Certain portions of the surface may be scratched and then scraped to remove certain parts which the brush does not seem to get under. Again, the use of the scraper may be followed with a vigorous scratch brushing, which will clean out all the chatter marks.

Tinning with a Scratch Brush.

For tinning certain metals, cast iron, for instance, a brass scratch brush may often be used to advantage. After the surface has been cleaned with the scraper and a steel wire scratch brush it may be brushed over with sulphuric acid and a brass wire scratch brush vigorously applied to the acid covered surface. Sometimes it is preferable to treat the surface with a scratch brush alone with-

out the acid. In either case, a thin deposit of metallic brass is left upon the cast iron surface, which much facilitates the soldering of that metal with ordinary soft solder.

Soldering Small Work.

The tinner must be prepared to do any kind of work, from soldering a couple of pins together to soldering a crack in the armor of a warship. Fig. 27 illustrates a

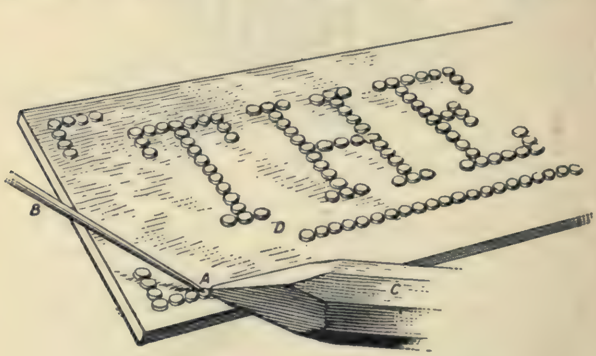


Fig. 27.—Soldering Small Work.

neat bit of work, a good deal of which used to be done, but which is not called for now to any extent. Still it will serve the purpose of illustration.

It used to be the rage for ladies to work all kinds of pictures and mottoes on cardboard with silk, worsted, etc., the cardboard having been perforated for that purpose. It was in the perforation of the cardboard that the soldering job, as shown by Fig. 27, was called for. To perforate the board a system of hollow punches was used,

each punch being about 3-64" in diameter and hollow at that. These punches were set in a long row, which would reach across the widest cardboard to be perforated. The row of punches moved up and down by means of a crank and cross head. Pieces of the cardboard to be perforated were fed along underneath the punches, step by step, from one end to the other, until every portion of the paper had passed, 1-16" at a time, underneath the row of vibrating punches.

As long as a punch came down without striking anything but cardboard, of course no holes would be made in the board, but if a small piece of brass were placed underneath the cardboard in such a way that one of the punches came down upon it, then a hole was punched. A small brass plate, having a length equal to the length of a row of punches, was so arranged as to have the cardboard clamped upon the top surface thereof and to move, step by step, underneath the punches, with the cardboard.

Upon this plate were placed little cylinders of metal, each about 1-16" high and the same in diameter. These cylinders were arranged so that one of the punches would come down squarely upon the top of each one. Thus if the design to be perforated in the cardboard were laid out in these little cylinders and then soldered to the brass plate D, Fig. 27, it is evident that holes would be punched in the cardboard corresponding to the cylinders upon the plate.

This was the case, and the problem arose how to attach the little cylinders to the brass plate and attach them evenly. This was finally done by soldering the design upon the brass plate, the little cylinders being put in place, one at a time or a dozen at a time, according as they stood alone or in rows. If a single cylinder was to be put in place, as shown at A, its position was first located, then held by the needle B, and the soldering copper C brought to bear upon plate D, while the end of the cop-

per bore against the cylinder A and was held in this position until both A and D became hot enough so that the solder on copper C diffused itself against A and along plate D.

Then the copper was removed and needle B kept in position until the solder had set upon A, when needle was removed and a fine file passed over the top of cylinder, which was then ready to work and would cause holes to be punched in the cardboard whenever the proper punch, in its journey, came down upon A. When a straight row of cylinders was to be soldered, as in the letters T, H, etc., they should be arranged in lines and held by means of a piece of grainer's comb. This is a small piece of thin steel, cut into teeth and closely resembling a coarse comb. This example illustrates the minuteness of small soldering and the care and attention which it is necessary to use when doing small sections of soldering work.

Heavy Soldering.

In contrast with this is the heavy soldering operation shown in Fig. 28, which represents some thick copper upon a church roof, being soldered and fitted around some of the ornamental work. There is nothing delicate about this job; instead, it is the most massive one imaginable. The seams have to be strong and heavy, and solder is consumed by the dozen pounds when doing a job of this kind. Instead of the light, delicate copper, shown at C, Fig. 27, the job represented by Fig. 28 requires the heaviest hatchet copper obtainable. Solder will be consumed in large quantities and heating the copper frequently will be found necessary.

This job is commenced at E, where a pool of solder is melted into the angle between sheet F and G. The copper is held in position as shown on the drawing, and plates G

and F are heated thereby until the solder E melts and diffuses itself over the surface of the plates in question. The copper is then moved along slowly and another pool of solder is flowed in, and this action is continued indefinitely. Unless the solder be very carefully rubbed against sheet

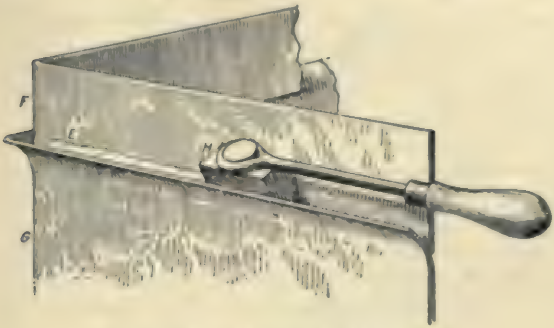


Fig. 28.—Heavy Soldering.

G or F, and unless the cleaning and fluxing be nearly perfect, the joint E will not prove as strong as desired.

Soldering with the Blow Torch.

In work like that illustrated by Fig. 28, the blow torch may often be used to advantage, the heat thereof being applied directly against E, also against sheets F and G. The handy soldering tool, Fig. 4, shown on page 14, chapter one, may be used to distribute the solder along the seam and to touch the places where the solder does not adhere readily, or, better yet, a copper may be used as shown by Fig. 28 and the blow torch also applied, letting the blast play against the solder as described, also against the copper, H. The blow torch, in connection with

the soldering copper, is exceedingly useful for heavy soldering and may be employed many times to advantage, the only disadvantage being that one needs three hands, one for holding the copper, one for the blow torch and one for soldering.

Soldering Heavy Work with a Light Copper.

The blow torch method, as described above, is particularly applicable to heavy work when only a light copper is available. Heat from the torch will almost keep the copper at working heat all the time, and when but one copper is at hand and work must be rushed out, the blow torch will be found a useful addition to the means of heating the copper. It is best not to run too large a flame when soldering as above. A small flame applied close to the point of the soldering tool seems to do the work better than a large flame sent against the body of tool.

Method of Tinning Brass and Copper.

Brass and copper tin readily and the process is an easy one. It is only necessary that the surfaces be clean and covered with a light flux of resin, oil or salammoniac. Any of the soldering fluids or soldering compounds may be used for tinning these metals, but salammoniac seems to be the natural flux for copper. It removes the oxide easily and a considerable coat of oxide may be removed with a flux consisting of powdered borax, powdered salammoniac and a little resin rubbed over the surface of the copper by means of a heated soldering tool.

It pays, however, to brighten the surface of copper with a scraper, a file, with sand paper or emery cloth before beginning to tin. For tinning some objects, both of brass and copper, there is nothing better and more convenient than a tinning brick, as shown by Fig. 8, on page 21 in

chapter two. Just place the article in a little puddle of solder on the brick, rub it back and forth vigorously with the copper and in less time than it takes to tell it, the tinning will be found complete and of the first quality. Brass may be tinned in the same manner as copper. It takes solder with even more readiness than the first named metal. Resin is the only flux required, but, as stated, almost any flux may be used with brass as well as with copper.

Tinning Zinc Surfaces.

Zinc is the most peculiar metal and requires treatment approaching that of cast iron. Zinc can be tinned with resin, with salammoniac and with several of the compounds and soldering fluids described in the preceding pages. The chloride of zinc solution may also be used for making solder take hold of zinc, but nothing known to the writer works as rapidly as raw muriatic acid and the acid need not to be too strong. Dilute with water to a certain point, as described on page 48. The acid takes hold of the zinc in a manner which permits hot solder to flow, as one tinner aptly stated it, "right under the surface." No soldering fluid known to the writer, as stated before, acts as readily with zinc as raw muriatic acid. The term "raw" is used to distinguish this form of acid from "cut" acid, which is the name given by the tinner to the chloride of zinc solution.

Heating with a Torch and Tinning with a Copper.

The several tinning operations described above and below may be expedited by heating the work with a blow torch and tinning it with a hot copper, in the usual manner. A well heated article tins much more readily than one which

is cold or which is only heated locally by the soldering copper. Bear in mind that all heat used in tinning comes from the copper and it will be readily seen that the copper must soon become cool to a point where it will not melt the solder. By heating with a blow torch, not only is the work done quicker, but much better results are obtained than is possible when tinning with the copper alone.

Tinning Iron and Steel.

The usual way of tinning iron and steel is by treating the surface with chloride of zinc and then applying solder with a hot copper in the usual manner. This requires a good deal of work and on large surfaces, the operation is rather costly. There is a method of electro-tinning which is very seldom used, but it may be employed with good results. when large surfaces have to be done. From two to three volts are necessary. Steel and iron should first be covered with copper before going into the tinning bath. If it is not desirable to copper iron and steel articles, they are first treated with a bath composed of fused protochloride of tin, one ounce in about thirteen gallons of water, then about two pounds of ammonia alum is dissolved in the mixture and the iron is boiled in this solution after having first been cleaned thoroughly and rinsed in cold water.

Steel and Iron Tinning by Boiling.

The bath is kept at its working strength by adding fused protochloride of tin as required. Iron and steel comes from this bath covered with a film of tin which is of a dull white luster, but adheres so strongly that it may be polished.

An alkali bath is sometimes used which consists of 4 quarts of water and 28 ounces of tin salts dissolved in the water. A precipitate is formed which requires potash lye

with a strength of 10 degrees Baumé to dissolve. This precipitate is zinc hydrate, and it is dissolved by the potash lye. If desired an ounce or two of potassium cyanide may be added, but from 3½ to 4 volts are required with this bath.

Tinning by Contact

Iron and steel may be tinned in a boiling tin bath by contact with zinc, pieces of which are suspended in the bath with the objects to be tinned. A bath for this purpose consists of 20 quarts of rain water, 28 drams of fused protochloride of tin and 7 ounces each of alum and pulverized tartar. These solutions must be boiling when used.

One of the best methods of tinning iron is to make up a solution of chloride of tin, almost exactly as ordinary chloride of zinc is made. Common block tin may be dissolved in hydrochloric acid, and if a little mercury is added it may be used for cold tinning.

Another rule is to use 1 part of tin to 2 of zinc and 6 of mercury. The mercury and tin, when mixed together, form a soft paste. The objects to be tinned should first be treated with potash to get rid of all greasiness, then moistened with hydrochloric acid. It is better to rub on the acid with a cloth or a brush. Cotton or similar fiber must be used for this purpose. Acid will quickly eat up any animal fiber, either woolen or bristles.

After the hydrochloric acid has been rubbed on apply a little of the tin paste described above and rub it over the surface with the same cloth used with the acid. The amalgam will spread itself over the surface and cover the iron and steel articles completely with a coating of tin. Steel surfaces covered with tin in the manner above described may then be soldered as if they were ordinary tin plate.

Tinning Hard Steel.

The articles to be tinned should be placed in dilute sulphuric acid and scratch brushed or scrubbed until every bit of scale has been removed. Mix up a bath of hydrochloric acid, 1 part in 20 parts of water, and suspend the articles in this bath for a few seconds, then immerse the object in a bath of tin which has barely melted. There should not be any more heat used than is necessary to make the tin fluid. If this precaution is taken the melted tin will not injure the hardness of the steel. Ordinary soft solder (half and half) melts at 466 degrees, according to the table given on page 36. Pure tin is supposed to melt at 442 degrees, but steel workers claim that the first tinge of color shows at 460 degrees; therefore, the tin bath, as it is used for tinning hard steel, approaches dangerously near the tempering point, so that there is great likelihood that the hardness will be affected when the tinning bath is used.

Ordinary soft solder (half and half) could be used as stated, according to Brannt, but not according to Kent. Brannt says this alloy melts at 370 degrees, while Kent says it melts at 466, or higher than the discoloring temperature of hardened steel, therefore caution must be used in employing a tinning bath. By using 2 parts tin and 1 part lead, which melts at 360, according to Kent and 340, according to Brannt, the tinner will be pretty safe as regards soldering without injury to the temper of steel springs and other hard objects, therefore if one uses a bath of 2 parts tin and 1 of lead he can be reasonably sure that the hardness of steel will not be injured.

If the steel articles have been oil tempered there will be trouble unless strong soda or potash is used for removing the oil. If tempering has been done in tallow there will be no trouble, as this substance does not interfere with the

adhesion of tin to steel, but where fish oil and mineral oil has been used it must be removed by alkali and the surface of the steel put into that condition known as "chemically clean."

Soldering Blued Steel.

Articles which have been tempered or blued and show a light color, either straw or blue, cannot be tinned without first removing the thin film of oxide which gives color to the hardened and tempered steel. A bath of dilute hydrochloric acid is necessary to remove this thin film of oxide; it will require only a few seconds' immersion to do so, after which the object should be dipped into the lead and tin bath while wet; place it immediately in the melted bath, as quick as it comes from the acid, and the lead and tin alloy will immediately coat the surface and form an excellent foundation for further soldering.

Tinning Rusty Iron.

Rusty iron or steel may be tinned in about the same manner as described elsewhere for clean iron and steel, with the exception that a preliminary operation is necessary for removing the coat of oxide or rust. This may be done by immersing the article in a solution of sulphuric or hydrochloric acid. In many cases the writer prefers to use mechanical means for removing the rust before placing in the acid. For this purpose the emery wheel, the scraper and the scratch brush may be used, as thought necessary. After most of the rust has been chemically removed the metal may be placed in the acid solution, which will eat under the coat of rust to an extent that renders it possible to rub off the coat of old oxide with a brush. The action of the acid upon the metal is to oxidize the surface. If left to become dry, this coat of oxide will effectually prevent

solder from adhering to the metal, but if solder be applied during the acid oxidizing process, the metal then being clean and free from either rust or grease, the melted tin and lead alloy will readily unite with the surface of the iron. Therefore, to tin rusty cast iron or rusty iron of any kind first remove the rust and then proceed by either process, described above, to coat the metal with tin or solder.

Tinning Galvanized Iron.

It is not absolutely necessary to tin galvanized iron before the soldering operation is begun, but it must be tinned before it can be soldered. The tinning operation may proceed at the same time that the soldering is being done. Chloride of zinc is not satisfactory for tinning galvanized iron; the best liquid to use is raw hydrochloric acid, which should be applied just before the copper is passed over the surface. As the hydrochloric acid dissolves the surface of the zinc and decomposes it into chloride of zinc or a solution of soldering salt, thus making ready the surface, acted upon by the zinc, to receive the solder at once.

Soldering Galvanized Iron.

When galvanized iron is to be soldered, it should be treated with strong raw hydrochloric acid, as noted above, then a well tinned copper, of large size, should be used and a plentiful supply of solder should be melted directly into the acid which has not evaporated from the surface to be soldered. The copper should be rubbed many times over the parts to be soldered so as to work the solder well down into the surface of the galvanized metal. As one tinner stated the matter, "The solder gets right down through the sheet" when raw acid is used. When chloride of zinc is used the solder does not go as deep into the metal as when raw hydrochloric acid has been applied.

Fitting Work Together.

When rusty iron or steel objects must be soldered together or any other pieces of metal as well, they must be closely fitted together if a strong joint is desired. Therefore in repair work where rusty objects are to be joined, scrape them clean and then hammer them closely together. As stated elsewhere, pieces cannot be fitted so close together that melted solder will not find its way between them and as also stated, the less solder in the joint, the stronger that joint will be. Hence the closer together the parts are fitted, the greater strength will be possessed by the joint after it is soldered.

Where there is an appreciable distance between two pieces which are to be soldered, it will pay to fit in a third piece of metal between them and make two soldered joints instead of one. The work will be much stronger, for the tensile strength of solder is quite low, and it is much easier stripped from the tin when there is an appreciable thickness of solder than when it is very thin and the objects are in intimate contact with each other.

Soldering with Tinfoil.

In some kinds of work, particularly in model work, where brass objects of considerable thickness are to be joined, tinfoil is used instead of solder. The surfaces are cleaned and made free from grease with a potash or a soda solution, then treated with a chloride of zinc solution and placed, one upon the other, in the exact position they are to occupy when soldered with a very thin sheet of tinfoil between them. The objects are then heated and pressed together, the tin unites with the zinc chloride and with the surfaces to be soldered and they are strongly united, pro-

vided they have been well fitted and pressed together sufficiently—so strong are they and so closely united that it is difficult to detect the fact that they have been soldered.

Sweating a Joint.

A variation of the tinfoil method consists of tinning both surfaces in the ordinary way, then pressing them together and heating until the solder, which is coated over the surfaces, melts and flows out from between them. The pressure should be sufficient to squeeze out all the solder possible and it is very essential that not a bit of solder be left between the surfaces and that no dirt be in the solder used for making the joint. After having been heated and pressed together as above, the objects are left until cool, when they will be found united more or less perfectly, according to the skill with which the sweating operation was performed.

Removing Superfluous Solder.

The operation described above necessarily causes a collection of superfluous solder on the outer edge of the parts which have been united. It is quite a task to remove the excess of solder after the objects have become cool, but it may be wiped off readily while they are still hot. For this purpose a bit of cotton waste may be used, or a piece of cloth folded several times makes a very good wiper. One of the best things for this purpose is one of the little wipe pads used by plumbers when making a wiped joint.

In tinning brass, or even iron, superfluous solder may also be removed from seams by means of the wiping off process noted above. The "tenderfoot" on the soldering range frequently gets too much solder on the work, and the experienced tinner sometimes drops a bunch of solder

where he does not want it. In cases of this kind just put the hot copper in the midst of the bunch of superfluous solder, letting the copper remain there until the solder is well melted and begins to spread itself over the surface. Have a folded rag or a pad in one hand, the copper being held in the other. Bring the rag close to the copper, until the solder spot is thoroughly melted, then with one motion pull the copper out of the way and follow it closely with the folded cloth. Give a rotary motion of the cloth, so as to bring a fresh surface against the solder. As the wiping proceeds, every particle of the solder may be cleaned off the work by a single movement of the hand in the manner above described.

Occasionally it may be necessary to make two or three wipes, but by allowing the copper to transmit its heat to the bunch of solder for 10 or 20 seconds an area 2 inches in diameter may be heated and wiped at one operation, or by giving the copper a lengthwise movement a longer and narrower strip may be cleaned off, as above directed.

Spirits of Salt.

Occasionally a tinner, particularly one of the old school, may be heard to tell about soldering with "spirits of salt." When hearing this dealer in would-be mysteries thus setting forth his supposed superior knowledge one may smile to himself because he knows that the fellow really means hydrochloric acid. Common salt is chloride of sodium and hydrochloric acid is simply water which has absorbed chlorine gas, as noted previously. Hydrochloric acid may be made by the action of sulphuric acid on common salt. The result is a large quantity of chlorine in the form of gas, which may be caught by water until the latter becomes saturated. The remainder of the salt is changed into a carbonate instead of a chloride by action of the

acid and becomes washing soda or salsoda, and by refinement bicarbonate of soda, or cooking soda, such as is used for household purposes.

The tinner sometimes calls muriatic acid "spirits of salt," because of the manner in which it may be obtained, as above described. When he speaks of "killed spirits of salt" he means hydrochloric or muriatic acid in which has been dissolved all the zinc it will take up or "cut."

CHAPTER VII.

WIPING JOINTS.

Soldering Lead Pipe.

Beyond all question, the best and strongest joint for lead pipe is that type which is known as a "wipe joint." A description of this joint will be given on the pages following, but the tinner is not supposed to know anything about that kind of work. When the tinner has lead pipe to solder, he usually makes a joint somewhat as shown by Fig. 29. One of the pipes, A, for instance, has been

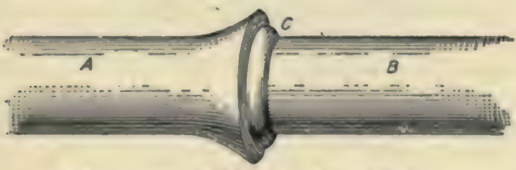


Fig. 29.—Soldering Lead Pipe.

flanged outward sufficiently to receive one end of the other pipe B, then the corner or angle between them at C is filled with solder, which has been run in with a hot copper and made to adhere to both pieces of the pipe. By this method of soldering lead pipe, the problem becomes merely one of heavy soldering, as described in the preceding chapters and illustrated by Fig. 28.

A pipe to be soldered by this method is first sawed off squarely by means of almost any kind of saw; a common

hand saw answering the purpose very well. A tapered plug is then procured, as shown in Fig. 30, and the small end is driven into one of the pipes to be soldered. This plug is not large enough to expand the pipe as much as required, therefore, after it has been driven in a short distance, it is given a rotary movement with the hand and rolled around and around just inside the end of the

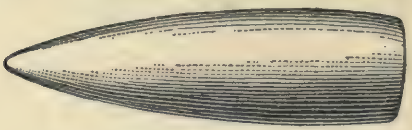


Fig. 30.—Pipe Expanding Plug.

pipe, thereby acting like the rolling mill to stretch the end of the pipe, little by little, until it has expanded to the required size and shape. When the pipe does not respond readily to the rolling operation, the tinner will tap on the side of the plug with a mallet, thereby hastening the operation.

In some sections of the country, the tinner uses different shaped plugs for expanding pipes. Plugs shaped

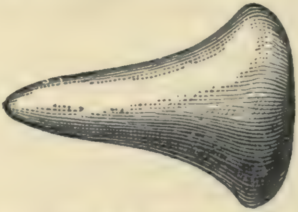


Fig. 31.—Parabolic Expanding Plug.

somewhat similar to that shown by Fig. 31 are to be found in use in some localities. This plug is used by simply

driving it into the pipe the required distance. It is a much handier device and does the work quicker, but does not last as long as the plug shown by Fig. 30.

A piece of pipe which is not treated properly by either of these plugs will look like A, Fig. 29. The end of the other pipe should have nothing done to it except that the end to be soldered should be filed off as shown by Fig. 32, at E.

The bevel is made such that when the pipe takes the place of the piece shown by B, Fig. 29, it fits tightly into pipe A, shown in that figure. This permits the inside of the pipe to remain smooth and straight without a lump or a cavity in it. Lumps may be made in poorly fitting pipes

Fig. 32.—Male End of Pipe Joint.

by some of the solder leaking through into the interior and remaining attached to the joint, thus reducing the pipe area a corresponding amount.

Pipes A and B, Fig. 29 may be brought very close together by pressing one into the other, and while the pressure is maintained, tap lightly all around pipe A with a piece of wood or a mallet. In this practice of pressing the pieces of pipe into intimate contact with each other, the irregularities are shaped down so that they fit each other, and it only requires a minute or two of this work to make an almost perfect fit between two pipes.

The soldering is preferably done while the pipes are in a vertical position, but the tinner will be able to solder them in almost any position. When they lie flat he must use one of the methods described in the preceding chap-

ter. He will commence at the bottom of the seam and work in the solder, holding it there with the wipe pad until he is sure both surfaces have been heated sufficiently for the solder to adhere. A joint of this kind may be fluxed with common resin or common tallow may be used, which is the flux usually employed on lead pipe when joints are to be wiped.

Having made sure that the bottom of a horizontal joint is well soldered, proceed a bit up towards the top according to the method described, until the entire joint has been closed in that manner. If it is desired to make a fine appearance of the joint, the solder which is in sight, as at C, Fig. 29, may be rubbed down smooth with a file or a bit of sand paper wrapped around a stick. When the pipe stands vertically, it should be arranged with piece A at the bottom. This permits a fine appearing joint to be made at C with no finishing whatever except that made by the hot soldering copper.

Imitation Wipe Joints in Pipe.

Sometimes the tinner is required, particularly in making repairs, to imitate a wipe joint, in appearance at least. This he may do, using an ordinary soldering copper and a rag or the wipe pad for the purpose. The pipe is prepared for the operation precisely as described for soldering, as shown by Fig. 29. One end of the pipe is expanded and the other end is filed to fit inside of the expanded portion. Fig. 33 gives some idea of a wipe-soldered pipe joint and the manner in which it may be made.

The pipes having been put together and hammered lightly until they fit closely and fastened either by placing bricks upon them or by otherwise holding securely, the pieces of paper A and B are wrapped around the pipes as shown and fastened with paste, pitch, oil or a string.

These pieces of paper are to prevent solder from adhering to that portion of the pipe covered by them. Next the scraper is brought into play and that portion of the pipe between the two pieces of paper is scraped clean and bright. The tool marks made by the scraper are shown at C. That portion of the pipe shown at D must be scraped clean and the scraping must be continued to the end of the pipe inside of the joint, therefore the scraping

Fig. 33.—A Wipe-Soldered Pipe Joint.

must be done before the pipes are placed together, as shown.

Making Wipe Joints.

While the tinner takes pride in running a continuous seam without showing the slightest irregularity in width or hight, free from all lumps, bunches and imperfections of every kind, the supreme test of the plumber's ability is to be able to wipe a joint in a neat and expeditious manner. Wiping joints is a very peculiar kind of soldering, and is used principally on lead pipe, but it need not be, by any means, confined to that metal, as it will work equally well with brass or copper. Even iron pipes may be put together with wipe joints if it is found necessary or desirable to do so.

A wipe joint, as ordinarily known and used, is the uniting of two or more pieces of pipe by means of a thick layer of lead and tin alloy, which is put in place while

in a plastic condition and finished by being rubbed back and forth with the cloth pad until solid enough to stay in place without being supported by the wipe pad.

Tools for Wiping Joints.

Different tools are required for wiping joints than are necessary for soldering ordinary seams. The copper is not used, the heat being applied by a stream of melted metal. The tools required for wiping joints are few and simple. A melting pot, shown by Fig. 34, is the principal tool. It is a small cast iron vessel, which will hold from

Fig. 34.—Melting Pot Used When Making Wipe Joints.

5 to 10 pounds of lead. It is usually heated over a firepot in the same way that coppers are heated. With this tool is used the ladle, Fig. 35, which is a small wrought iron or steel affair, having a bowl perhaps 2½ inches in diameter and three-quarters of an inch deep.

Scraping a Pipe to be Wipe Jointed.

Pipe is prepared for a wipe joint almost exactly in the manner shown by Fig. 29. The scraper is used and the manner of its application is illustrated by Fig. 36. Every

particle of the outer coating of oxide is removed from the pipe, and every particle must be removed or a perfect wipe joint cannot be made. The pipes are then put together

Fig. 35.—Ladle Used for Making Wipe Joints.

precisely as shown by Fig. 33, except that the female end is not expanded quite as much as for the wipe soldered pipe joint or for a straight, soldered joint. It is only necessary that one of the pipe ends be enlarged sufficiently to contain the other end.

Having scraped the pipes, expanded and placed them together, a piece of paper or some blacking is put on each pipe, as shown at A and C, Fig. 37. The object of the blacking or paper is to prevent the solder alloy from adhering to the pipe, except on the portion B, which is to be covered by the joint. The pipes are placed in the exact position they are to occupy when the joint has been completed. Some pieces of scantling, or some bricks, F and G, are laid on the floor, as shown, and the pipe carefully assembled upon them. To keep the pipe in position, some bricks, D and E, are placed as shown, thus holding the pipe firmly in place upon the bricks or scantling, above noted. The portion to be wiped, shown at B, is covered with a thin layer of tallow, which acts as a flux.

Solder for Wiping Joints.

The solder necessary for wiping joints depends upon the melting point of the metals to be joined. Lead melts at a

temperature of 626 degrees Fahrenheit. The solder used must have a melting point less than the lead in order that the solder may be poured over the joint to be wiped until

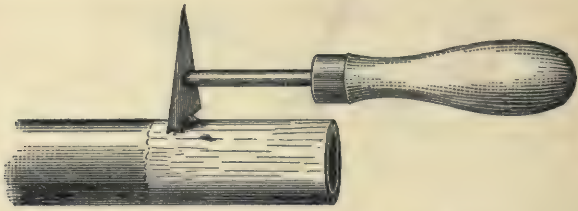


Fig. 36.—Scraping Pipe to Be Joined.

the surface of the pipe has become heated to the required degree. To make up a solder best adapted to making wipe joints, an alloy should be selected which melts far

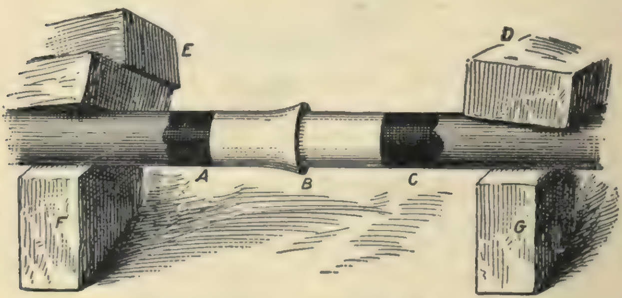


Fig. 37.—Lead Pipe Prepared for a Wipe Joint.

enough below the melting point of the lead so as to insure perfect safety against the lead pipe being fused by the solder.

Pure tin melts at about 455 degrees and the problem is to select an alloy of lead and tin which fuses considerably below the melting points of pure lead or tin. Half and half solder should melt at 370 degrees. Two and one solder—that is, two parts of lead and one of tin, should melt at 441 degrees. The plumber frequently makes up a pot of solder, to suit his fancy, by melting down a couple of sticks of half and half solder and then adding about an equal weight of lead pipe to the melting pot. This gives an alloy with a melting point which should not prove injurious to pure lead, and the solder thus obtained may be applied to the prospective wipe joint without fear of melting or otherwise damaging the pipe.

Heating a Pipe for Wiping a Joint.

Having prepared a pot of wiping solder, as above described, heat it until barely melted. A very good way to determine the proper temperature at which wiping solder should be used is to insert a clean, soft wood stick in the solder and note whether the alloy is hot enough to burn or char the outside of the wood. A bit of white pine, whittled smooth, is best, but white wood will answer, though it is not as satisfactory as white pine. A common match, with the head held in the pliers and the opposite end inserted an inch or so in the hot metal, will tell the story. If the wood does not char after being immersed a second or two the metal may be regarded as being at the proper temperature, and heating of the joint may be commenced preparatory to the wiping operation.

Applying the Melted Solder.

The beginner in joint wiping should bear in mind that the making of a wipe joint is carried out in three separate and different operations. The first is preparatory,

and consists of scraping and placing the work in position, as already described. The next operation is the heating of the pipe. The pipe must be heated as thoroughly as when applying solder with a copper, but there being no copper used in making wipe joints, the necessary heat must be applied by and from the melted solder.

Fig. 38 shows the beginning of the heating operation. The lamp black or paper stops, A. and B, having been applied at the extremities of the proposed wipe joints,

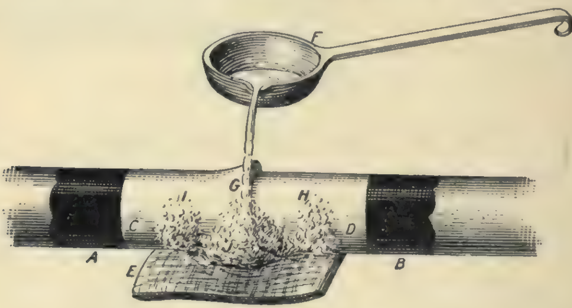


Fig. 38.—Beginning a Wipe Joint.

and the surface, C and D, having been scraped and covered with tallow immediately after they are brightened, the pad E is placed underneath the joint. It may be held in the hand, supported by a couple of fingers, which are protected from the hot metal by the pad itself. It may be better, safer, at any rate, for the beginner to spread a paper on the floor underneath the pipe and not try to catch the heating solder. Be this as it may, the experienced wiper will take a small portion of melted solder in ladle, F, and pour a very small stream, as shown, upon the pipe at G. The stream of solder should be the smallest that it is possible to pour. Seemingly

the stream of solder is not larger than a needle; certainly it should never be larger than a match, and should be poured so slowly that while it leaves the ladle in a continuous stream, it breaks up into drops by the time it reaches the pipe at G, and falls in a series of splashes over the pipe. The workman will hold the ladle far enough above the pipe so that the metal separates into globules or drops as it reaches the pipe, but not so high that the metal splashes or spatters. In fact, the hot metal must stay right where it strikes, otherwise there will be danger of burning the fingers.

The ladle should be moved around and around until the hot metal hits successively at H, I, etc.—in fact, is carried all over the surface of C and D, and finally a bunch of metal gathers at J and is caught upon pad E, which need not be held close under the pipe, but may be at C. During the heating operation the beginner's pad may be replaced by a piece of cloth or paper laid on the floor.

Returning Solder to the Pot.

After a few seconds' pouring of the melted alloy, a considerable bunch of metal will have collected at G, and as the pouring continues and the heating advances this bunch of solder will slide off and fall upon E, as shown at J. This shows that the heating operation is progressing satisfactorily, and the stream of metal should be at once directed on some other portion of C and D in order to heat those portions also. The novice may use half a dozen ladlefuls of metal in the heating operation, but an experienced person will not use as much.

The accumulation at J, which falls upon the pad, may be returned to the melting pot, or if the metal in F seems too hot, some of the metal caught at J may be returned directly to F, thereby reducing the temperature of the

hot metal to a more satisfactory point. As the heating progresses a bunch of semifluid metal can be heaped up on top of the pipe, as shown at A, Fig. 39. The pad B is shown in the position of pushing the mass of solder, A, in an upward direction.

It is evident that heat from the mass of semifluid solder, A, will dispose itself lengthwise along the pipe until the solder is so far cooled that it will solidify, or, in other words, it freezes, for that is exactly what happens when any alloy is cooled below its melting point. The mechanic will watch this very closely and move solder A about the pipe by means of pad B; he will no-

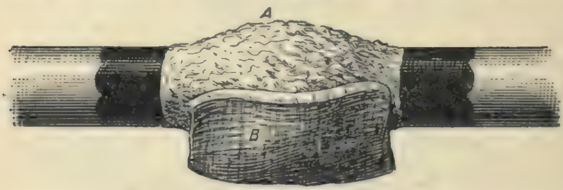


Fig. 39.—Heating the Joint.

tice if it begins to adhere to some portion of the pipe, and immediately pour a little more hot solder into the mass at the point where it is inclined to freeze. In this way the workman is able to keep the mass moving over the entire surface of the pipe which is to be covered by the joint, and the moving is continued until the workman sees that the solder adheres to each and every portion of the scraped surface. As in soldering with a copper, it requires a little rubbing of the surface to be soldered. The wiped joint is no exception to this rule.

The melted mass A is rubbed around on the joint until it adheres closely to every point of the scraped and tallowed surface shown at C, D, Fig. 38. If too much melted solder be applied the mass A, Fig. 39, will be-

come fluid and will slump off; in other words, it will slide off the pad B and fall upon the floor, in spite of all the workman can do to prevent it. Such accidents will happen many times to the inexperienced plumber; he should "let her slide" and devote all his energies toward keeping the hot metal off his fingers until he has learned to control the mass of alloy. After the trick has once been learned it is surprising how easy it is to keep half a pound of solder moving around a piece of lead pipe with a single wipe pad. The solder seems to stick of its own accord, and, in fact, it would be more work to get it off the pipe than to keep it in place. This is because the necessary "know how" has been attained.

Coating a Wipe Joint.

Having gotten some of the solder so that it may be wiped around and over every portion of the proposed joint, the workman lays the ladle one side and takes another pad in the hand and proceeds to work the solder over and under and back and forth, as shown by Fig. 40. The object of this is to make sure that the solder

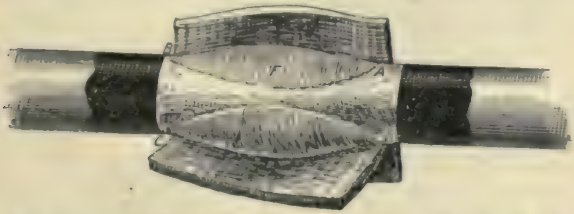


Fig. 40.—"Working" Solder on a Wipe Joint.

adheres perfectly to each and every portion of the joint. The edges of the pad are brought close down to the pipe at the points A and B, C and D, and the forefinger and

little finger of each hand are used to hold the pad closely against the pipe, thus throwing the bulk of the solder to the center of the joint at F, where it belongs.

By working around and around the pipe the workman can readily see any places where the solder does not adhere to the lead. If a place be found that will not coat itself over by the back and forth movement, the workman will lay down one of the pads, take the ladle again, and work directly upon the non-adhering portion of the pipe until it takes coating like the rest of the joint. Considerable deftness of touch is required to keep the solder from dropping off the bottom of the joint, but this is a knack which can be acquired by practice alone. A man may be told a thousand times how to do the job, but unless he gets right down to actual practice he will never catch the little kinks and tricks which make up the wiping of a joint.

The Joint Wiper Must be an Artist.

Wiping a pipe joint is an operation which requires considerable artistic ability on the part of the workman. It is impossible when making a wipe joint, to employ only bull-headed brute strength. Delicacy of touch is required, close observation of the conditions of the pipe and a nice sense of proportion are also necessary. A man who lacks in any of these qualifications may surely wipe a joint, but a bunch here and there, one end heavy and the other light, more solder on one side of the joint than the other, will certainly be the result. The man who can wipe a good joint and have it present a true symmetrical appearance, has the same artistic idea of form which enables the modeler in clay to work out pleasing and perfect designs. The artistic instinct is the same as that which shows itself in the work of the man who brings out graceful lines and symmetrical forms no matter whether he is cutting a piece

of tin, framing up an intricate design in a galvanized iron window or ventilation work, or painting a picture.

Finishing a Wipe Joint.

The workman now puts his artistic talent into action and distributes the solder symmetrically around the joint, as shown by Fig. 41. A single pad may be used for this work, both forefingers being employed to press the pad against the ends of the joint and the rest of the fingers being used to regulate the pressure along the center of the

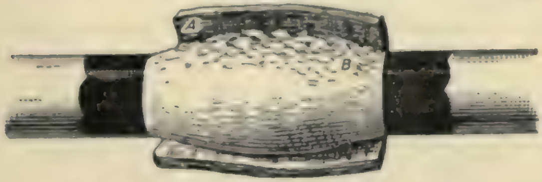


Fig. 41.—Finishing a Wipe Joint.

pad. By moving the pad in this way, it acts as a scraper and pushes before it the bunch of undistributed solder, shown at A B. As this solder is worked back and forth around the joint it is distributed, as required and gives a symmetrical form to the joint.

If it be found that there is too much solder on the joint, a portion of it is removed with the pad, one edge of which is formed into a scraper wherewith the superfluous solder is cleanly removed from the joint. The entire operation of wiping a joint should not take more than three to five minutes after it has been prepared to receive the solder. It must be done quickly or the solder will freeze and require another application of the hot metal from the ladle. But this should be avoided, as a patched joint can never be as good as one made by a single, clean operation.

Should the beginner fail to get a good joint upon the first attempt, he is advised never to try to patch the joint, but to apply some hot solder-metal from the ladle and melt the solder off the joint until it is clean and in the same condition as at the beginning of the operation, then try again, with hopes of better success. If too much solder has been applied it will squeeze out between A and B, Fig. 41 and finally take the appearance of a crest or lip, as shown at F, Fig. 40. This is a very annoying condition, but it results more from inexperience than anything else and it may be remedied by continual practice at joint wiping.

When to Quit Wiping a Joint.

When to quit wiping a joint is a problem which confronts the beginner. If he does not get the joint done quick enough the solder will freeze and the pad will make no impression on it. If he tries to shape the solder too quickly, before it is cooled to the right temperature, the joint will slump and will not stay in place; the lower portions may be bulged out or perhaps drop off. Another point requiring attention is that if the joint be wiped while too cool, the surface will be stringy and full of ridges, lines and spots of loose solder.

Poorly Finished Wipe Joint.

Sometimes the workman persists in finishing a joint by lengthwise strokes of the pad, as shown by Fig. 42. This form of finishing is a very poor one and should never be tolerated by even an inexperienced joint wiper. It is very easy to give lengthwise strokes with the pad, thereby removing the light crest or edge of solder, which forms along the joint, under the pad. The beginner should practice on this point until the pad can be removed from the

joint without leaving a perceptible mark at the point where the pad left the solder. Fig. 43 shows the proper form of wipe joint finishing. The faintest lines or marks may be seen at A and B, and these lines mark a point where the

Fig. 42.—Poor Form of Wipe Joint Finishing.

pad finally left the joint after the pressure thereupon from the fingers had been reduced until the mere weight of the pad bore upon the solder.

A Correctly Finished Wipe Joint.

The line shown at A and B, on Fig. 43, where the joint and the pad part company, is so light as to be almost indistinguishable. On some joints it is almost impossible to

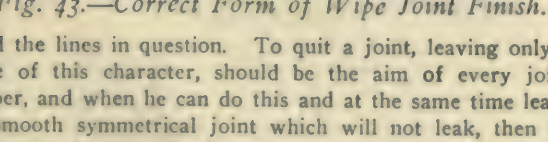


Fig. 43.—Correct Form of Wipe Joint Finish.

find the lines in question. To quit a joint, leaving only a line of this character, should be the aim of every joint wiper, and when he can do this and at the same time leave a smooth symmetrical joint which will not leak, then he may truly be classed as an extra good joint wiper. It will require a good deal of practice to attain this ideal, also, as stated, considerable artistic ability.

A man may be able to make a good strong wipe joint, but which absolutely lacks all beauty of finish. In fact, as one plumber stated the matter, "the joint was so blamed homely that flies wouldn't roost on it." A man who makes a joint of this kind should put in his spare hours of practice and in the cultivation of form. A man does not want to make wipe joints like unto the ox sled made by a farmer, with only an axe and a saw for tools. He made the sled all right, and a right good sled it was, too, but it looked so homely that the farmer was unable to get the oxen hitched to it without backing them on. The tinner who aspires to wipe joints should never make them so homely that water refuses to run through.

Some Defects of Wipe Joints.

The man who is learning to wipe joints must use eternal vigilance in order to construct a joint which will stand the wear and tear of long service and which will not contain one or more of several defects to which wipe joints are liable. Two of the most common defects are shown by Fig. 44. It will be noticed that a cavity exists at A, at

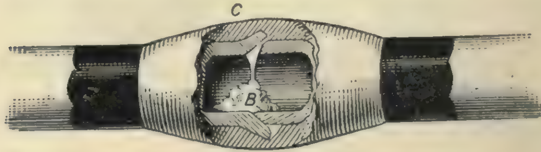


Fig. 44.—Some Defects of Wipe Joints.

the bottom of the joint. Cavities of this kind usually occur at the bottom, but may occur at any portion of the joint. Such a cavity is caused by the hot metal being wiped quickly from the angle between the two pieces of pipe and sufficient care is not exercised to form

a union between the hot solder and the cold pipe. The writer has seen joints where defects like that at A were found around almost the entire circumference of the pipe. The joint wiper was evidently doing contract work and working against time at that. He simply gave the joint a "lick and a promise" and never tried to do more than to give a presentable finish to the outside of the joint.

In some parts of the country, water corrodes lead pipe quite readily, especially when connected with the hot water front of a cooking range. Cases like A have been found where there was only a thin skin of solder over the joint, and when this corroded through there were holes innumerable, where leakage could and did take place. The joint wiper should watch very closely when starting a joint to see that the solder adheres to every portion of the joint.

A Leakage Defect.

Another quite common defect is shown at C. This defect causes the trouble shown at B and represents an opposite condition to that which caused the trouble at A, which, to a great extent, was owing to solder being applied which was too cold, while the trouble at B may have been caused by solder which was too hot. It may also have been caused by poor fitting between the ends of the pipe at C. A combination of both causes may have been present, but, be that as it may, the hot solder found a hole at C, and the portion which runs down and piles up at B reduces the pipe area greatly, and in some instances forms an obstruction which will decrease the flow of water to a dangerous extent. A way to guard against this defect is to make sure that the pipes are fitted together properly and that the solder is not too hot. A remedy for the trouble shown at A is self evident. It only needs a little care and some good workmanship. There is no excuse for either of these

defects in joint wiping by an experienced wiper, but the beginner must look out for both of them.

Other Wipe Joint Defects.

The beginner in joint wiping must be very careful that the solder is not too hot, or he may melt a hole right through one section of the pipe, or he may even melt out the entire joint. There is also danger that the lead pipe may be softened by the too hot solder and gradually sink down, almost closing the opening in the pipe. The experienced wiper should detect such an occurrence immediately, but the novice, not knowing what to look for, does not observe the slight, horizontal spreading of the joint which usually accompanies the flattening down of a joint in this manner, therefore he may consider the joint to be perfect outside when really the interior of the pipe has been closed as effectually as though it contained a plug valve or a stop cock.

When a flatted joint of this kind is cut in two, it much resembles in appearance a piece of stovepipe which has been run over by an automobile. The wiper should watch for any external distortion or the pipe when applying solder. The margin of safety between the melting point of solder and that of the pipe is such a few degrees to begin with, and if solder be heated hotter than will barely char a white pine stick, then there is danger that the pipe may be softened and cave in or that a leak will develop which will fill the interior of the pipe with solder, as shown by Fig. 44. On the other hand, the wiper must avoid solder which is too cold, as he is liable to have "cold shuts," as shown at A, which latter is almost sure to develop into an aggravating or a dangerous leak.

Wipe Joint Precautions.

In addition to avoiding the defects noted in the preceding paragraphs, the workman who is to make a wipe joint should observe several other precautions. The first is to see that the work is dry. Moisture in or on the pipe is very apt to cause trouble, if it be contained inside of the joint where it will come into contact with hot solder. A portion of water is liable to be turned suddenly into steam and to throw the hot solder viciously in every direction. Severe burns are frequently caused by contact between hot solder and water in this manner.

If there is the least suspicion that water is present, pour a little gasoline on the joint and set it afire. It will quickly burn out, and the heat thus generated will drive off any water which may be present. When drying the pipe with gasoline, care should be taken that much of the fluid does not run inside of the pipe. If this be permitted when the gasoline is ignited, there may be a small explosion, which will be uncomfortable, if not dangerous. Such an explosion may tumble down the joint which had been assembled ready for wiping, therefore take great care of this gasoline moisture.

Hold the Work Solid.

It is the usual custom of the joint wiper to place the pipes together in the position they are to occupy when soldered and hold them by piling a few bricks on top, as shown by Fig. 37. This answers very well in certain cases, but where short pieces of pipe are to be handled, there is nothing which will hold them in position so well as a couple of "C" clamps. These handy little tools are made of cast or malleable iron and present an appearance something like that shown by Fig. 45.

Two or more of these clamps applied to a couple of pieces of pipe will hold them securely. A small wooden frame may be used for attaching the pipe and the clamps to, or an empty soap box with a hole cut in one side will answer the same purpose. The man who has once used clamps of this kind in wiping joints will not return to the brick method when he can get hold of the clamps.

While water may not do any damage, when present in a joint, it can never do any good, and invariably will delay

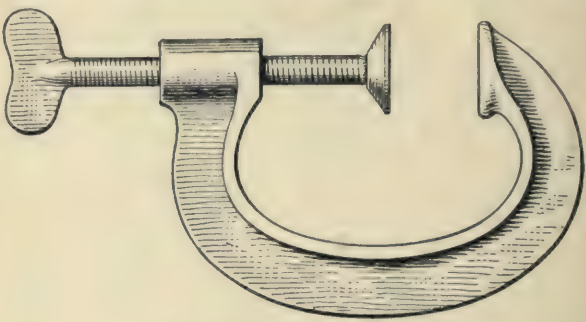


Fig. 45.—"C" Clamp.

the soldering operation, because heat enough must be applied to dissipate the water in the form of steam or vapor before the soldering can proceed. Sometimes, instead of throwing the solder about, water will simply cause the joint to sputter and snap and then dry out, permitting the soldering operation to proceed. It causes just so much delay, this burning out of the water, and, as stated, is a source of danger, which may at any time develop into a serious accident. Therefore, always be sure that no water is present in the joint.

Test Pipe to be Wipe Jointed.

It may happen that pipe is placed upon the market which has a melting point lower than that of pure lead. It is well for the beginner to test out pipe by cutting off a small section of the pipe and immerse it in a pot of melted solder, at the temperature which it is intended to use in wipe jointing. If the pipe has too low a melting point it will be fused by the melted solder, and while the expert will be able to wipe a low fusing pipe with a higher fusing solder, it is a delicate operation, which may prove troublesome to the novice. To be sure, the conditions are somewhat different in the test than they are in actual practice, as in the test the pipe is immersed in the melted solder, while in actual practice the hot solder is poured upon the pipe; therefore there is more danger of melting the pipe when immersed than when the solder is poured upon the pipe.

Still the test of pipe is to be depended upon, for the reason that if it will not melt in the solder pot it surely cannot melt when solder is poured upon it. It may be added that the solder during this test should be carefully tested with a clean pine stick, and it should not be heated hot enough to char the surface of this stick. Should the solder prove to have too high a melting point the workman must add more tin to the solder; if he has some "fine" solder this will answer, otherwise he may melt in "half and half," but it will require more of the "half and half" to reduce the melting point of a pot of solder than it will if "two and one" be used.

Flux for Wipe Jointing.

As stated, tallow is the proper flux for lead to be wipe jointed. The mechanic should take care to obtain a

good tallow, for this substance is often adulterated with cottonseed oil or fish oil, and then does not give good results as a flux for lead. The best way to obtain good tallow is to buy a piece of suet from the butcher, put it in a porcelain lined kettle with a tight fitting cover, and place in a kettle of water, where it will be kept hot, for several hours. If there is a steam boiler in the shop, just set the tallow kettle on top of it, and melted tallow will always be ready for use when needed. Usually a place for the tallow kettle can be found around the stove which heats the shop, or it can be attached to a steam radiator; only take care that it does not get afire and that all dirt is excluded.

If dirty tallow must be used for pipe wiping flux, the tallow should be strained through several thicknesses of cheese cloth or some other thin fabric to remove the dirt. Do not use resin on the pipe when wipe jointing, although it is well to place some resin in the pot where the solder is melted. A little shop dirt—that is, seepings from the floor, with a little powdered resin mixed with it, may be kept on top of the melting pot, and will prevent oxidizing of the solder. It is necessary, however, when using the solder, that the coat of dirt be removed, or at least that it be poked back to one side of the pot, so that clean solder may be dipped out with the ladle.

Care of Wiping Pads.

Some precautions should be taken with the pads used in wiping joints. They are preferably made of bed ticking, although any thick, heavy cloth may be used and a form of asbestos pad used in the household for holding laundry irons, may be used to advantage. These pads may be purchased for five or ten cents at almost any store, particularly at the so called five and ten cent stores.

These pads should be well tallowed, outside at least, before they are used for wiping joints. Take care, too, that they are thrown away before they become too thin, as hot solder has a nasty way of getting uncomfortably close to the fingers when it is used with a thin pad.

Ornamenting Wipe Joints.

In Figs. 38 to 44 the pipe is shown with a section of black attached to each wipe joint. The man who is wiping joints usually chooses to ornament (?) the pipe with a more or less elaborate design, worked in black at each end of the joint. Personally, the writer does not regard this practice as adding to the appearance of the pipe. It seems to disfigure more than to ornament, but it forms a handy method of stopping the solder. The job would, according to the writer's fancy, look better if the black were removed with a little benzine after the joint has been completed. If desired, the use of lamp black for this purpose may be avoided; many joint wipers do not use black at all. They simply wrap a piece of newspaper around the pipe, as shown by Fig. 33, and the paper marks the end of the wiped portion of the joint and prevents solder from adhering to the pipe, thus protected by the paper.

CHAPTER VIII.

SOLDERING WITH ELECTRICALLY HEATED TOOLS.

A form of soldering, which has come largely into use in late years, is known as the electrical method and the electric soldering tool has come to stay. Several varieties of the electric soldering copper are on the market. One very common form is shown by Fig. 46. In appearance the tool

Fig. 46.—Electric Soldering Tool.

very much resembles the ordinary form of copper except that the handle or shank is greatly enlarged, as shown at A. In ordinary types of electric soldering coppers, the bit B has been cut down in size for the reason that there is no use for a mass of copper to retain heat. One of the uses of the ordinary soldering copper is to convey and impart heat to the object to be soldered, therefore it is necessary that considerable heat be stored in the tool, hence for heavy work, a bulky copper is necessary.

Electric Method of Heating a Soldering Tool.

In the electrically heated tool, there is no necessity for a large amount of heat storing metal, for the heat is applied

continually by means of an electric current and can be imparted to the bit as fast as it is drawn therefrom by the actual soldering operation. The usual method of applying electric heat to the soldering tool is by means of a coil or loop of some substance which offers great resistance to the electric current. An alloy of iron is used for this purpose in many coppers and is wound in a small spiral upon a non-conducting center of asbestos, clay or similar substance, the resistance wires being wound in a shallow groove or thread on the outside of the central core, the groove or thread serving to keep each turn of the wire from touching its neighbor, thereby forcing the electric current to pass around and around, through every turn of the wire in the tool.

Should a coil become disarranged so that the coils touch each other, the current will pass from one coil to another direct and the result may be, aside from the loss of heat and power, the burning out of the fuses in the conducting wire and even the wires may be damaged or destroyed by the excess of current. Some coppers do not use a coil of wire but the resistance wire is made in the form of a loop somewhat similar to, but much smaller than the film in an ordinary incandescent lamp. The comparatively large size of the shank A is for the purpose of containing the resistance coil or loop, the handle being large enough that the coil may pass through it, wholly or partially into the bit B.

One Cause of Trouble.

One cause of trouble in the electric soldering tool is due to the fact that metal expands greatly when heated and the higher the degree of temperature, the greater the amount of expansion. The coils wound around the core of a soldering copper increase in diameter as heating proceeds and the wire may be thrown out of the groove

in which it is wound by a sudden shock like that caused by the tool falling on the floor or its being used as a hammer. Hence the need of great care in handling the tools and also of a strict injunction against their being used for any purpose except that of actual soldering. These tools should be handled as carefully as though they were made of glass. More tools go wrong, are damaged or even destroyed, by careless handling, than by the actual work of soldering.

Current for Electric Soldering Tools.

Electric soldering tools must be purchased for the current which is to be used in them. A copper wound for one form of current may not work satisfactorily with another form. These coppers may be constructed to be used upon a direct current of 500 volts, and such a tool would not work when attached to a current of 100 volts, but no harm would be done to the tool by thus attaching it. On the other hand, a soldering tool made to be used on a 100 volt current, would be burned out almost instantly were it attached to a 500 volt circuit unless suitable resistance had first been placed in series with the electric soldering tool.

Resistance in Series.

By the term "in series" it is understood that a suitable resistance, say an incandescent lamp, be connected so that the current passes through both the lamp and soldering tool, one after the other. When connected in multiples or in parallels, which means the same thing, both the tool and the lamp should be connected to the conducting wires like the rungs of a ladder, so that the current can get through both lamp and tool at the same time. The series con-

struction is absolutely necessary with electric soldering tools, as the same current which goes through the lamp must also go through the tool.

Resistance for Low Voltage Soldering Tools.

A long coil of wire may be arranged as a resistance whereby a low voltage soldering tool can be used on high voltage circuits. In case of necessity, when a low voltage tool must be used on a high voltage circuit, and no suitable resistance is at hand, a water rheostat may be quickly rigged up by the use of two carbons or pieces of metal in the following manner. Cut the conducting wire and attach one of these carbons or electrodes, as they should be termed, to each cut end of the wire. Immerse the electrodes in the vessel of water and adjust them close together or farther apart, as may be found necessary to give the quantity of current required by the soldering tool. Considerable heat will be evolved in the water rheostat, but it is not a very economical appliance as a good deal of energy is wasted. In fact, all the heat evolved is caused by wasted power, but the water rheostat will enable a low voltage soldering tool to be used on a high voltage circuit.

A Common Form of Electric Soldering Tool.

A common form of electric soldering tool as shown in Fig. 46 is from 10 to 18 inches in length and fitted with a hollow, wooden handle, through which a piece of flexible cord is run, connecting with wires or small screws, in the metal handle. This section of the handle is shown at A and its use is to contain the heat generating portion of the circuit, as described in the preceding paragraphs. Sometimes soldering tools are made with two wires projecting from the wooden handle; again, both wires are inclosed in a knitted or woven fabric similar to that used on telephone

cords. This form is the most desirable, as it leaves only one wire to take care of during the handling and using operations.

Connections for Electric Soldering Tools.

The free ends of the insulated wires are attached to a plug, which may be connected to an ordinary incandescent lamp socket, in the usual manner and the current turned on by turning a switch in the socket, exactly as though an incandescent lamp were being switched on. A form of socket very desirable for soldering coppers, which may be used in connection with the ordinary screw socket, is what is known as the slip plug socket. This is so constructed that in case of a pull of a few pounds upon the wires (the twisted pair, as they are called), the slip plug will come out of its socket and no damage will be done to either the tool, the wires or the lamp socket to which the tool has been connected.

Time Required for Heating Electric Coppers.

After turning on the current, not more than ten minutes should elapse before the copper is hot enough for soldering and the tool remains thus indefinitely, if the circuit is not broken and the tool is not used for heavy work, beyond its capacity. In case the copper suddenly cools, examine the socket to see that it is in working order and that the plug has not been accidentally loosened. If these fixtures are all right and the copper is not badly in need of re-tinning, then look for the trouble on the inside of the handle. Upon disconnecting it, it will probably be found that one of the wires in the flexible cord has become broken or detached. All that is necessary to be done, in that case, is to cut off a piece of the flexible cord, or twisted pair and connect up the ends again.

Trouble in the Winding.

But perhaps the trouble may be more serious, as in the winding inside of the metal handle; in that case, the man who is using it should, by all means, send the tool to the electrical hospital and have the doctor look after its "innards." If the man who is using the tool chances to be an expert electrician, then he may safely delve in the hidden portion of the copper, but if not, he should no more try to fix an electric soldering copper than he should try to fix a watch. Any attempt to do so, in either case, by an inexperienced man, is apt to lead to further trouble and expense.

When soldering with an electrical soldering tool make sure of one which can be operated ten hours per day. Not every electric tool possesses a ten hour working efficiency. Each electrical tool should be built to maintain what is known as "critical temperature." This is essential to high grade soldering and it can, and should be, maintained at all times.

Care of Electric Soldering Tools.

The man who has been accustomed to throwing a two pound block of copper into a fire pot has a good deal to learn before he can use electric soldering tools to advantage.

Not only is there a lack of information regarding such tools, but there is much misinformation and prejudice regarding the range of usefulness and limitations of electric soldering tools.

With the furnace heated coppers it is possible to get a very high temperature and by having a much larger mass of copper apparently get a more effective tool on the work than is the case with the electric, owing to the fact that the

maximum temperature of the copper is easily made greater than the electric tool can reach.

Speed of Electric Soldering Tools.

The mechanic is used to having quicker action in melting solder when applied to the work than follows with the electric tool. At first the workman will become impatient because it is slower when applied and cannot be run as rapidly as the big heavy, high heated copper for a short time, consequently he condemns the electric. This is almost invariably the case in a tin shop if the mechanic be left to reach his own conclusions and be governed by his own determination. On the other hand where the electrics are put into a shop, their forces explained and the man required to use them and no other, he will in the course of time learn their characteristics and prefer the tool in most cases.

Sure and Quick Heating or Slow, Steady and Continuous.

The furnace heated copper after it is prepared and ready for the work—very hot—is a satisfactory tool for a short period. The time required, however, to care for the furnace, to dress the copper, to tin it and clean it and to wait for its reheating or the time spent in retinning the overheated copper, calls for far more of a man's time to accomplish a certain result than is required with the clean electric copper, which does not become overheated and burn off the tin, but which cannot be crowded or forced for short intervals as can the furnace heated copper. With the electric tool the man must go a bit slower, but he goes quite steadily and, as explained, when the man has learned his job the electric tool satisfies him far better than the old style furnace heated copper.

Overcoming Prejudice against the Electric Soldering Tool.

It requires time and favorable conditions in the shop in the way of proper attitude of mind, because a mechanic who for years has used a peculiar kind of tool will be a very long time in giving up his prejudice in its favor for something that is different, no matter how much better it may be, even though not better in every respect. The writer has had several well pronounced cases of this kind. In a certain shop where electric coppers only are used, the foreman was several months in coming around to the opinion that he preferred that kind of tool but he will not willingly go back to the old copper and fire pot. Every man who comes into this shop has to be given an appreciable time before he will admit that the electric tool is desirable, but in the end, having from necessity used the electric copper for a considerable period and realizing that he cannot turn to some other tool, then the change of opinion is complete. The electric copper is taken for what it is worth and not one man of them would go back to the old style tool.

Delicacy of Electric Soldering Tools.

Some manufacturers, after they have tried these coppers, present another phase of the matter. The complaint is made that the tools are delicate and not substantial. Really, this is not the fault of the tools, but of the use to which they are subjected. As intimated in the preceding paragraphs, the furnace heated soldering tool is a lump of copper which may be thrown about without care, used as a hammer on occasion and otherwise subjected to rough treatment. The electric copper, while not being tender,

may not be used as a hammer and should not be thrown across the room or upon a bench from a distance. The electric tool can be handled on a bench much the same as any other ordinary bench tool and handled without more care and without danger of injury, but the electric copper should not be misused.

Bear in mind that of the two instruments one is a crude rough affair suitable for use by brute strength and similar intelligence, while the electric tool is a high grade creation and when handled accordingly will give results which never can be reached by the old fashioned soldering copper.

Injury of Electric Soldering Tools by Acid.

One point which should be well looked after in handling electric soldering coppers is that of preventing their injury from acid and acid fumes. Soldering solutions contain more or less corrosive substances and as corrosion is more active when metals are at a high temperature than when they are cold, it will be seen that heated soldering tools are especially susceptible to corrosion from the acid above mentioned. Therefore care must be taken to prevent the acid from reaching the heater and the shell covering the heater of the tool should always be protected and by no means should any acid be permitted to reach the joint between the shell of the tool and the heater flange.

Not only should acid be kept away from the electric tool but the fumes of the acid should be eliminated. Nine mechanics out of ten will dash the hot copper into a cup of hydrochloric acid and they care not whether the acid has been "killed" or is "raw." The cloud of vapor which arises when the copper is plunged into the acid means speedy destruction to the electric soldering copper. Even if not put completely out of business the tool will be in bad shape after two or three months of such treatment.

Electric Tools Should Not be Dipped in Acid.

Even when care is used in dipping the copper, more or less acid will cling to the tool and the vapor penetrates the joints and finds its way into the electric wiring, where a low red heat is being continuously maintained, the parts are still more susceptible to the effects of acid fumes. Even when the copper is lying upon the bench, if dipped frequently in acid while being continually hot, both the tip and the shell will pit and corrode and the acid will find its way into the interior of the tool and attack the heater. It is totally unnecessary to dip the electric soldering copper into acid. Under every circumstance which may arise in the shop this action is unnecessary. It should and must be prohibited.

Stands for Electric Soldering Tools.

Even when continually in use a copper must be laid down at frequent intervals and sometimes it remains temporarily out of use for several minutes at a time. A support should be provided whereby the electric tool may be laid clear of the bench and where it will not be injured by throwing other tools upon it and where it will at all times be ready for the hand. Neat little stands are provided by the manufacturer of electric soldering copper. Some of these stands are arranged so that when the copper is laid on them they automatically cut in series with the copper, a considerable resistance which is contained within the stand. This reduces the flow of the current to the copper, thereby reducing the cost of operation. The tool not being in use can, of course, be kept hot with less current than when it is working.

Good Form of Tool Stand.

A very good form of stand consists of a slate base provided with yokes or sockets of cast iron. Some users of electric coppers make a mistake in providing a sort of bed or nest made of asbestos into which the copper is thrust when not in use. This is a very bad practice indeed. Such devices are very injurious because they act as a jacket around the heater and cause the temperature to run up to an undesirable point, even high enough to injure the resistance wire which means the copper and in some cases to decompose the mica by which the heater is insulated from the body of the tool.

Temperature of Electric Soldering Tools.

It should be kept in mind that the heater of an electric soldering copper is maintained at a low red while the tool is in use therefore by preventing radiation of heat by surrounding the tool with asbestos or other nonconducting material, the temperature of the heater is raised to a point which might seriously damage if not completely destroy the coil which keeps the tool hot.

Selection of Electric Soldering Tools.

A workman who has never used an electric tool will be at a loss to decide what size is best suited to his work. Each manufacturer puts out from three to a dozen sizes and shapes and gives an idea of the service to be expected from each. The tables herewith presented give the size, weights and rating of tools supplied by three prominent makers. The first four or five columns of these tables are self explanatory. The last column gives the weight in pounds of a tool which will be displaced by the

electric tool, the description of which is given in the same horizontal line.

It should be also kept in mind that the electric tool will displace two ordinary coppers instead of one. Therefore a tool which weighs 27 ounces actually displaces two coppers of 1 pound each, or 2 pounds in all. Likewise a big electric copper weighing 100 ounces will displace 8 pounds of copper.

"G. E." Electric Soldering Tools.

with permanently attached plug or handle guard ring.

Diam. of tip in inches.	Weight in ounces. Tip.	Complete.	Watts.	Volts.	Weight in lbs. of equivalent soldering copper.
½	2	25	75	95-105 106-115 116-125	1 lb.
¾	8	28	100	116-125	1½ lbs.
1	16	33	150	116-125	2 lbs.
1¼	32	42½	200	116-125	3 lbs.
1½	48	54	275	116-125	4 lbs.

The above described line of tools is the latest to be put upon the market. Other makes of electric tools have been on the market for several years, but the "G. E." Company did not go into the field until they were absolutely sure that their tools were capable of doing everything claimed for them.

Cartridge Type of Tool Heaters.

The heating end of these tools is of the cartridge type, and to secure the most effective location it is placed right in the tip, which also is easily renewable.

A peculiarity of these tools is the open wire handle illus-

trated by Fig. 47, which can never get hot, as the construction is such that the heat is dissipated as fast as it is transmitted into the handle.

The manufacturers of this tool claim that the big advantage possessed by it is due to the use of calorite for the manufacture of the resistance or heating coil. It is also claimed that this substance has a very high specific resistance and that it is extremely unoxidizable under high temperature.

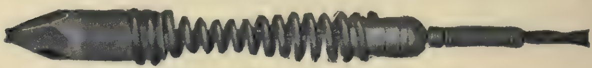


Fig. 47.—"G. E." Electric Soldering Tool.

Another advantage possessed by these tools is that the calorite wire is wound in a single layer upon the lava core. Many tools have two coils of heating wire, but the "G. E." has only one, and this is insulated in a German silver cartridge shell with a paper thin mica insulation in the same manner as the standard cartridge unit. The complete unit slips very closely into a hole bored in the tube, which entirely surrounds the cartridge.

Life of "G. E." Soldering Tools.

As stated elsewhere, the particular tender spot of electric soldering tools is their liability to overheat while not in use if kept turned on. Of course when the tool is in use the heat is carried away by the act of soldering as fast as generated, but when the tool is left on the stand for a considerable length of time, with the current turned on in full, there is apt to be serious overheating, and perhaps damage to the insulation or heating unit unless special means are provided to take care of the excess heat.

It is claimed that the calorite wire is so little affected by oxidation that it will permit the tool to run for several thousand hours, doing no soldering whatever, being constantly connected.

Tests of the life of a tool running dry, so to speak, i. e., doing no soldering work, have been made by the "G. E." Company to determine the actual life, and they have found that tools run constantly for over 8,000 hours are not affected in the least and are as good at the end of the test as when the tool was new. This is equivalent to at least two and a half years at ten hours a day.

Vulcan Soldering Tools.

From the table herewith given and data pertaining to the Vulcan tools, it will be noted that while the ½ in. "G. E." tool weighs 27 ozs. and requires 75 watts to displace a 1 lb. copper, the Vulcan ½ in. tool, weighing only 12 ozs. requires but 70 watts. This tool, however, will displace only ¾ lb. of ordinary copper tool.

VULCAN SOLDERING TOOL.

Diam. of tip in inches.	Weight in ounces.	Watts.	Volts.	Weight in lbs. of equivalent soldering copper.
½	12	70	104, 110, 115, 120	¾
			200, 220 or 230	
⅞	18	150	do. do.	1½
1⅛	29	250	do. do	2¼
1⅜	26	350	do. do.	3
⅞	16	120	do. do.	1
7/16	9	55	do. do.	½
½	9	60	do. do.	¾

The general appearance of the Vulcan tool is shown by Fig. 48 and it will be noted that the handle is separated a considerable distance from the soldering tip by means of a wasp-like body connection of considerable length.

The Vulcan people give some excellent advice about the care of soldering tools. They advise:

1. That the tip be screwed in tight and kept tight as the tool will thus heat better. They also state that the tips should be filed to point them. They should never be hammered, as hammering spoils the threads.

2. Acid or sal ammoniac solution destroys copper and they note that as electric tools have no soda or grease they do not need strong solutions.

3. In removing the tip never grab the heating head or stem with a vise wrench, pliers, or other instrument.

Fig. 48.—Vulcan Electric Soldering Tool.

The shell will surely be crushed and the threads be destroyed by such action.

They also avoid the use of a hammer upon the shell or stem.

Unscrewing Soldering Tool Tips.

Their simple directions for unscrewing the tip is to tap it sharply on all sides with the hammer, while holding the heating head with the hand, then put the tip in the vise and unscrew the heating head with the hand. Never use anything besides the hand for this purpose. If the heating head sticks keep on tapping the head as above directed until it does unscrew.

They state furthermore: Never to use grease in the shell or case, also keep both of these parts free from acid.

Simplex Electric Soldering Tools.

This tool is shown herewith by Fig. 49 and the data is given in the following paragraphs in the form of the usual tables.

Fig. 49.—Simplex Electric Soldering Tools.

This tool needs very little description as the engraving enables the observer to see exactly how it looks and the table gives the necessary data.

SIMPLEX SOLDERING TOOLS.

Diameter.	Weight in ounces.	Watts.	Volts.	Weight of copper displaced.
½"	13	95 to 220	75	¾ lbs
⅞"	18	"	75	1
1"	25	"	100	1½
1¼"	26	"	220	2
1½"	28	"	275	3
1¾"	35	"	350	4
3"	102	"	450	6

Selecting Soldering Tools.

The following paragraphs give some idea of the use to which these tools may be applied and will enable the beginner in their use, to select just the one he needs.

The following list of tool numbers and watts required will be referred to in the paragraphs immediately following.

SELECTION OF TOOLS.

No.	Watts.
1	55
2	60
3	70
4	150
5	120
6	250
7	350

The No. 1 tool is used for extremely light soldering, very light telephone multiple switch board repairs, electrical instruments, smallest fuses and in fact for the lightest of all light work.

No. 2 is used on bench and open work where a very light wire tip is wanted. It is especially adapted for the telephone or linemen's tool kit.

No. 3 is for the ordinary telephone switch boards, for electric instrument work and for very light manufacturing fuses.

No. 4 is used for fast repair telephone work, for light tinware and for automobile work. This tool is also suitable for general home use and when an electric soldering tool is to be added to the family tool kit this particular tool should be selected.

No. 5 is almost similar to No. 4. This tool is recommended where shortness is important.

No. 6 should be used for ordinary tin shop work, general manufacturing, medium tin metal patterns and automobiles.

No. 7 is the tool to select for very heavy tinware and sheet steel and galvanized iron work. Metal boat making requires this tool and it is also necessary on refrigerator work.

Electric Branding Appliances.

It may be interesting for the mechanic to know that any of the electric soldering tools may be transformed into first class branding tools by simply unscrewing the tip and replacing same with a brand made to suit requirements. This is a great convenience in certain kinds of work as the tips and brands are readily and quickly interchangeable.

Care of Electric Soldering Tools.

The writer desires to emphasize and reiterate the necessity for great care in using and handling electric soldering tools. Like a watch, the higher the grade of tool the greater the care necessary and this applies to electric soldering tools above all other appliances. Also many of these tools are made with air tight binding chambers to protect them from destructive flux fumes. As stated elsewhere they are damaged or destroyed by the persistent use of strong acids and strong solutions, therefore care for the electric soldering tool as you would care for a high grade watch and no trouble will be found in their continual use.

CHAPTER IX.

BRAZING.

The term brazing, as generally understood, means joining together of two pieces of iron, steel, or other metal by means of a film of soft brass. Anybody may, with propriety, use the term brazing to indicate the soldering of two or more pieces with an alloy of copper and zinc, but as soldering is commonly understood as joining metals by an alloy of tin and lead, it is better to leave out this definition and use the term brazing instead.

Brazing and hard soldering are almost identical in effect as well as in operation, except that in the former brass is used as the union metal while in the latter silver or an alloy of that metal is used as the uniting medium.

There are a great many metals which when melted and brought in contact with other heated but unmelted metals will unite themselves thereto and form a one-sided species of welding in which the union to all intents and purposes is as complete as when both metals are melted together or welded.

Methods.

There are several methods commonly employed for brazing and the one which should be selected depends upon the conditions and requirements of the work in hand.

The most common method may be called brazing by radiant heat, in which the parts to be united are fastened

together by means of wire rivets and then held in a very intense heat until the spelter or brass melts and runs between the pieces to be joined.

Brazing by Conducted Heat.

Brazing by conducted heat is another method by which the articles to be united are fastened together outside by brackets and evenly united and speltered, then they are clamped together with a pair of red hot tongs which melts the spelter and it flows into the joint and unites the metals more or less completely according to the skill of the operator.

Brazing by Immersion.

Brazing by immersion is another method by which the parts, when thoroughly cleaned and securely fastened together, are plunged into a vessel containing melted spelter or brass and held therein until sufficiently heated so that the brass unites the parts to be joined.

Brazing by Electricity.

The electric method of brazing is another but slightly employed method. The articles are prepared much the same as for electric welding, but instead of being pressed together as they become heated they are merely clamped and a current applied until the spelter melts and flows into the joint. This method is, perhaps, the handiest and neatest of all ways of brazing, but as yet it has not come into general use.

Brazing or Hard Soldering?

There is very little difference between brazing and hard soldering except that brass instead of silver is used in the former operation.

Various Methods of Heating for Brazing.

The heating may be done for brazing by the blow torch, as illustrated by Fig. 9 of this series, or the blow pipe may be used, an instrument which is shown by Fig. 11. Even the blow torch furnace, illustrated by Fig. 10, may be used to advantage in brazing; and the blow pipe used in connection with the pliers and a piece of rosin, as shown by Fig. 13 and Fig. 14, may also be used to excellent advantage.

The air gas blow pipe, Fig. 15, and the gasoline blow pipe arrangement, Fig. 16, may also be relied upon to do a great deal of heavy work.

By building up around the work with charcoal or wood chips and blocks a very large area may be heated and a bigger job may be done with these tools than the man unacquainted with this work can have any idea of.

Materials for Brazing.

There are innumerable alloys used for brazing but three or four will be enough for any ordinary work. It is usual to purchase spelter already prepared for brazing. It is in the form of a crushed or granulated powder and in this condition is easily mixed with pulverized borax. If the mixture be wet slightly, barely moistened, it may be easily placed upon the joint to be brazed by means of a small brush or bit of stick.

Perhaps the brazing mechanic had best prepare four alloys, two hard and two soft, which we will call hardest, hard, soft and softest.

Alloys for Brazing.

Alloys.	Tin.	Copper.	Zinc.	Antimony.
Hardest	0	6	2	0
Hard	0	2	2	0
Soft	2	8	6	0
Softest	4	0	0	0

In a number of test books a metal is given for brazing as follows: Zinc, 1 part; fine brass, 1 part. In making an alloy of this kind it is understood that the copper in the brass receives still another proportion of zinc which lowers the melting point and therefore makes the alloy much softer.

Fluxes for Brazing.

Borax and boracic acid are the two principal fluxes used for this purpose. Some mechanics prefer one, some the other, and some men mix the two together in varying proportions. The writer has the opinion that it makes very little difference which one is used; he uses either one and can see no difference in the results obtained with either.

Applying Borax and Spelter.

The old style brazer used to dust a lot of borax upon the work, then place the piece of brass upon the borax and watch the fusing of the borax, which invariably pushed the brass off of the work. The writer has seen an old timer of this kind replace the brass three or four times upon the join. Each time he replaced it he would dust on some more borax. This is unnecessary; sifting on borax once or twice is usually enough for a single job. It is only required that the borax diffuse itself over the

join to be brazed to prevent access of the atmosphere to the heated metal. As long as the thinnest film of the borax remains on the work there is no need of applying more flux.

Wet or Dry Fluxes.

The question as to whether to use borax powdered, pulverized, wet or dry has never been satisfactorily settled or at least mechanics have not agreed upon any one method as being better than all others. The finer the borax is pulverized the less apt it is to "boil" when losing its water of crystallization, for this is what happens when the pieces of borax start up and turn themselves inside out before melting and becoming diffused over the metal to be brazed. Finely divided borax melts much quicker than lumps, therefore the disturbance is less great and less likely to upset the brass or spelter and push it out of place.

Brazing by immersion, as briefly described on page 145, is effected by wiring firmly together the articles to be brazed and then thrusting them into a body of melted spelter, after treatment with the proper flux of course, and holding them beneath the surface of the metal until the articles have been heated to the proper degree of temperature.

Upon removal from the bath the surplus spelter will readily fall away or may be taken off, leaving the articles perfectly brazed together. Fig. 50 shows a tank for brazing by immersion.

An immersion tank is usually of cast iron shaped somewhat as shown by Fig. 50, but it may be made square instead of triangular if desired. The object of making the triangular vessel for containing the melted spelter is merely for giving sufficient depth and width of immersion space with the smallest possible body of metal. This end

is obtained with a vessel shaped as shown by Fig. 50. There is no objection to using a vessel with a round cast iron bottom if so desired and for some work such a shaped vessel might be necessary.

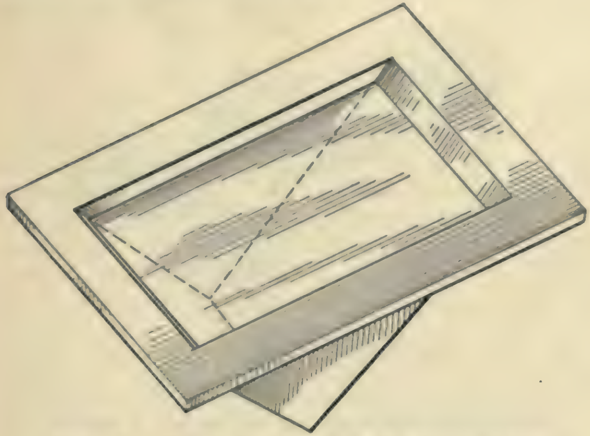


Fig. 50.—Tank for Brazing by Immersion.

Preparing Work for Immersion Brazing.

Fig. 51 shows an example of fitting up two pipes for brazing by immersion. Pipe A is to become a branch of pipe B. A hole is made in pipe B and pipe A is fitted as perfectly as possible against B and it is better if there is no perceptible opening between the pipes at the point of junction. Once they are fitted together they are wired tightly in position, the wire C being passed around beneath the pipes and twisted firmly together at D. Previous to this the metal has been for some distance brightened around the junction of the two pieces.

The brightening shown at E may extend a convenient distance on either side of the junction; it makes no difference how far provided it is far enough for the width of join intended to be used. This, of course, depends upon the size of pipe to be brazed and ranges from ⅛ of

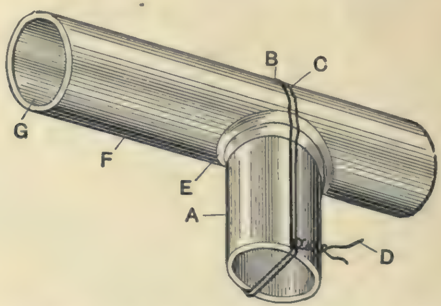


Fig. 51.—Pipe Wired and Blackened for Brazing by Immersion.

an inch on very small pipes to 1 inch or 1¼ inch on very large pipes.

Scraping and Brightening.

Having brightened the pipes and wired them together proceed to blacken every portion of the pipe except the joint E. In fact all the surface must be covered with plumbago blackening to prevent adherence of the spelter. It will be noted that the pipe is blackened at F inside as well at G, even the wire is blackened, in fact every portion except the narrow strip around the joint as shown at E.

After the blackening has become dry some borax is dusted upon joint E and the whole business is lowered into

the immersion tank. It requires but a very few seconds for the pipe to become heated, then it is removed and gently shaken to remove the superfluous spelter which adheres over the brightened portion E and comes from the bath looking as neat as any wiped joint ever made by the best workman.

Rapidity of Immersion Brazing.

The rapidity with which brazing may be done by the immersion method cannot be equaled by any other method of brazing. It is not very convenient, however, for very large work, but with immersion tanks large enough to contain bicycle frames, the bicycle manufacturer makes quick work of his brazing.

Pipe Brazing Clamps.

Sometimes it is not convenient to wire together the parts to be brazed. In such cases permanent clamps may be made for that purpose, one of which is shown by Fig. 52 This form of clamp is particularly desirable for brazing Y joints. It is almost impossible to wire such joints in place so that they will stay while being brazed.

The clamps illustrated consist of two pieces of iron or steel drilled for three bolts, each carrying a thumb nut. Loose clamp pieces are fitted to the radius of the pipe to be handled and serve to give better contact between the pipes and the clamp. With a clamp of this kind it is only necessary to place the pipes in position, screw the thumb nuts down tight, drive the joint firmly together with a hammer, then paint with plumbago, immerse in the tank or braze in any other manner convenient.

Brazing Pots and Kettles.

Fig. 53 shows a form of brazing which is not done now as often as it was before the invention of the drawing press. Presses are now made which will form up almost any shape of pot, kettle or other cooking utensil from a

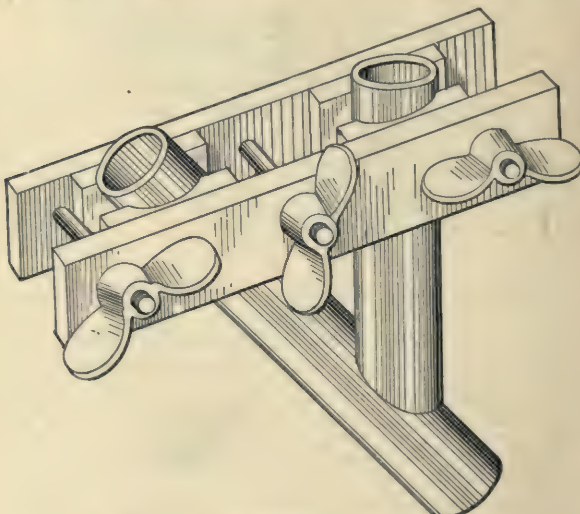


Fig. 52.—Brazing a Y Joint.

single flat sheet of metal. But in some work brazing like that shown by Fig. 53 is still necessary, particularly in making stills.

In this engraving it will be noted that the ends of a sheet *a a* are brought together and dovetailed. Furthermore the dovetails are riveted as shown as *c c* to prevent the plates from coming apart sidewise. The rivets are given

a shallow heading so as to prevent the dovetailing from coming apart. Work of this kind is usually executed in copper. The brazing necessarily must be done with a metal which has a lower melting point than copper and is, as stated elsewhere, an alloy of equal parts of copper and zinc.

A similar line of dovetailing is shown at *b b* where the bottom of the pot is joined to the sides. The bottom

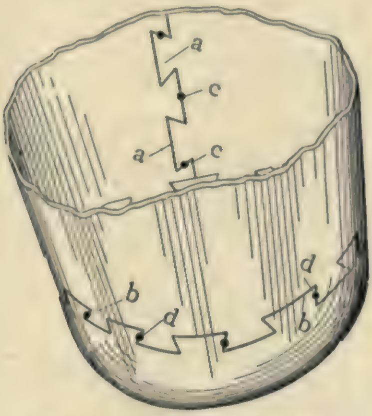


Fig. 53.—Brazing a Pot.

is usually hammered to the requisite shape, a thick sheet being used which when hammered will be drawn down to the proper thickness. Flat rivets are put in this dovetailing as shown at *d d*, after which the brazing is effected usually in a fire somewhat larger than that used by a blacksmith. The brazing fire as used by coppersmiths is so made that it can be enlarged to almost any required dimensions. It can be spread out into a long narrow fire

or widened out into a large square area over which the heat and flame are very easily distributed.

Brazing a plate, as shown by Fig. 54, is an entirely different matter and one which often taxes to the utmost the skill of the mechanic. A curved sheet, as in a pot

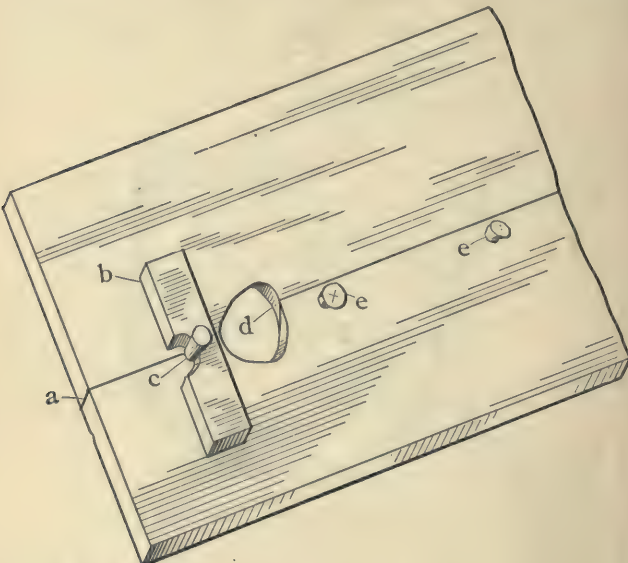


Fig. 54.—Brazing a Plate.

or cylinder, is easily held in position but with a flat plate it is sometimes very hard to keep the edges perfectly true with each other. Two methods are shown by Fig. 54, the butt joint and the lap joint. The latter is much the easier as far as brazing is concerned but is a much more costly

joint to make owing to the work in bevelling the edges of the sheet.

The joined section is shown at *a*, and at *b* is shown a clamp which is merely a flat bit of bar iron placed upon the joint as shown. A similar piece of metal is placed on the other side of the plate and a rivet *c* is driven through both and slightly headed to hold the plates firmly together in the clamp. A bolt may be used in place of a rivet but it is more expensive because after brazing it is usual to cut the rivet away with a cold chisel in order that the clamps may be removed, but if a little care is taken to braze on either side of the clamp to not get any brass under or into the clamp then the bolt or rivet may be easily driven out, the clamp removed and the space brazed where the clamp was applied, but as it is much easier to braze right through under the clamp as well as other places, it is as stated usual to lightly rivet the clamps together, then knock them off with a cold chisel after the brazing is completed.

Lap Brazing Plates.

The lap method, as stated, is easier as far as the actual brazing is concerned. A lap of this kind is shown at *d*, Fig. 54, and to hold the lap in position rivets *e e* are drilled through the lap and lightly headed down. After the brazing has been effected the rivet heads are filed away, leaving the surface smooth. The lap method makes a stronger joint than can be effected by butting the plates together.

Brazing Valve Stems.

Several methods of brazing valve stems are shown by Fig. 55. Brazing in automobile work is a good deal like welding. That is it is forbidden to be used in automobile

construction. This, however, applies to the mechanism of the engine and the running gear of the carriage, but not to the ornamental work or to the joining of the conducting pipes and similar articles.

A valve stem may be so brazed that it will be as strong as a solid stem, but on the other hand there are many

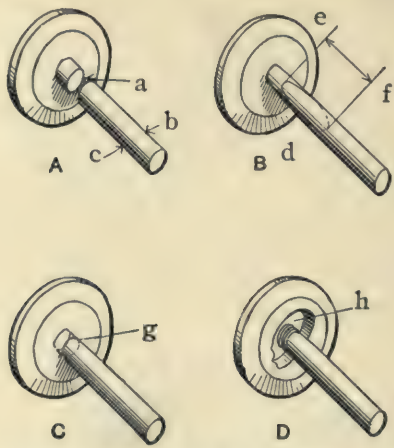


Fig. 55.—Good and Bad Brazed Joints.

ways of brazing stems which are not acceptable and should be forbidden in automobile work.

In Fig. 55, sketch A, the stem is to be brazed at *a* and the diameter of the stem *c* is quite small, probably not more than a ¼ of an inch. If the stem be butted square together, as shown in A, it is evident that a very weak joint will result and the strength of the joint can be no greater than if the entire valve were made of soft brass. Such a joint is tabooed in automobile work.

Sketch B shows the lap method of brazing a stem *d* which is flatted off from *e* to *f*, shortening the stem that amount but permitting the parts to lap a considerable distance. When well brazed this forms a quite strong union between the parts, but, unfortunately, as valve stems usually break close to the head, it is not often that we can make joints of this kind.

A very common form of stem brazing is shown by sketch C. Here a hole is drilled through the body of the valve, the stem is driven in, riveted slightly and then brazed. This makes a very good joint but it is not quite good enough for automobile work for there is a possibility of the brazing becoming loose, allowing the stem to slip in and out of the valve head.

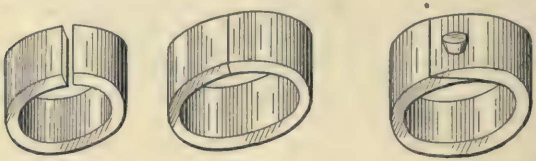
The only form of brazing a joint which should be tolerated in automobile work is shown by sketch D. Here a hole is drilled through the valve head as above but the hole is made much smaller and instead of having the stem driven in the hole is tapped and a thread is cut upon the stem, after which they are screwed together as tightly as possible and the outer end of the stem riveted lightly over the valve head, then after the brazing has been effected a joint is the result which is only weaker than a solid stem to the extent of the difference in the diameter between the valve stem and its diameter at the bottom of the tapped thread.

Brazing Ferrules.

The beginner in brazing usually proceeds with a ferrule for a chisel handle or for a knife handle. Usually the ferrule consists of a bit of hoop iron cut to the right length and rolled up until the edges butt together. Ferrules are shown by Fig. 56 and it should be noted that in sketch A the joint is a very poor one. Only one edge

of each end of the strip of metal touch together. This joint can be brazed but there will be 1-16th of an inch of brass in the joint and it goes without saying that the joint will be much weaker than if the steel had been fitted closely together, as shown by sketch B.

This sketch shows a very well fitted joint and the resulting ferrule will be strong and good looking. There will be a wide streak of brass the entire length of the object.



A B C

Fig. 56.—Brazing a Ferrule.

When extra strength is required in a ferrule the joint shown by sketch C should be employed. Here the metal has been scarfed and lapped and to make it fit as tight as possible a small rivet is drilled through the lap and lightly headed down. The novice in brazing need not be afraid that he will fit the joint so well that no brass will get into it. That is impossible. If a hole be drilled through a plate and a plug driven into that hole as tightly as possible then the plug may be riveted on each side of the plate and subjected to the brazing operation, after which it will be found that the brass has followed through the entire thickness of the plate beside the rivet. Therefore no matter how closely the joint may be fitted brass will find its way into it during the brazing, and as stated the closer the fitting and the less brass in the joint the stronger it will be.

Fig. 57 shows a good method of holding the ferrule dur-

ing the brazing operation. A bit of wire is turned at right angles forming a sort of hook upon which the ferrule is suspended with the joint downward.

Fig. 57.—Heating a Ferrule Braze.

This engraving quite plainly shows the manner in which the bricks of spelter are disposed inside of the ferrule. This makes a very good place to put the brazing material and it is not apt to be knocked off during the heating operation. In addition to this less brass is left on the outside of the ferrule, necessitating less work in cleaning up and brightening the object.

Cleaning Brazed Joints.

When brazed articles are removed from the fire with the molten brass flowing over them, means should be taken for removing at once the superfluous brazing material and not permit it to solidify into globules which must be removed when cold by means of fire or emery wheel. When the work comes from the fire as soon as the brass "runs" then the superfluous metal may be easily wiped off with a piece of metal wire or a stick or a little scratch brush may be employed to advantage.

Dropping Brazed Articles into Water.

Some people make a practise of dropping brazed articles into water immediately after they are removed from the fire. The certain evolution of steam by the red hot metal tears away the scale and the superfluous brass from the surface of the metal leaving the articles quite smooth and clean. This method is good in some cases but it cannot be used with steel articles which would be injured by being hardened as would be the case if plunged into cold water when in a heated condition.

Brazing a Band Saw.

One of the most common operations which the mechanic has to perform is joining together the ends of band saws. Joints of this character are required in saws of ⅛ inch in width up to 7 inches or even 8 inches in width. Saws of such large size, however, are seldom met with except in the lumber regions where they are used for the economical cutting out of lumber. The brazing operation is much the same whether the saw be ⅛ inch wide or many times that width.

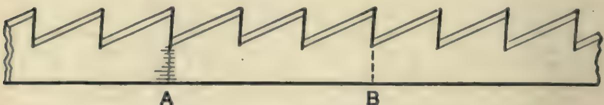


Fig. 58.—A Well Brazed Band Saw.

An excellent job of saw brazing is shown by Fig. 58. A slight mark or shading is visible at A. This mark indicates one end of the lap in the saw which covers three teeth in length.

At B is another very slight marking but it is on the opposite side of the saw at the other extremity of the lap.

Fig. 59 is a very good example of "How not to do it." It will be noted that the teeth do not match each other. A job of this kind should never be turned out by a mechanic who prides himself upon his brazing ability. Further comment regarding this engraving is not necessary, it speaks for itself.

Methods of Holding and Brazing Band Saws.

Several methods are in use for holding and brazing band saws, and the time honored clamp illustrated by Fig. 60 is perhaps the best known piece of apparatus for saw

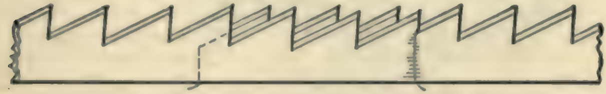


Fig. 59.—A Slovenly Job of Saw Brazing.

brazing. The clamp is made of two or three pieces and they are steel. The one illustrated by Fig. 60 is composed of two pieces, the lower one having been channeled in a planer to receive the upper or smaller piece of metal. After the two pieces are fitted together and fastened by means of two bolts and thumb nuts then a notch is cut in the middle of the tool as shown and here the work of brazing the saw is carried out. Two holes are shown at C and D and screws may be put into these holes and into the bench or some other adequate support for the brazing clamp.

A saw is shown in position ready for brazing, being clamped in the tool, and it will be noted that the notch extends back beyond the saw at the point where the braz-

ing is being done while on the other side of the notch the back of the saw bears firmly against the body of the clamp thereby keeping the saw perfectly straight.

It will be noted that the ends of the saw fit together in a very peculiar manner. They are slightly bent so that both ends of the lap touch while the middle of the lap is a small distance apart. The saw is purposely fitted in this way in order that a sure contact may be made with each end of the lap. With the saw in position as shown by Fig. 60, with a thin piece of soft brass placed between the ends of the saw and with a liberal dusting of borax

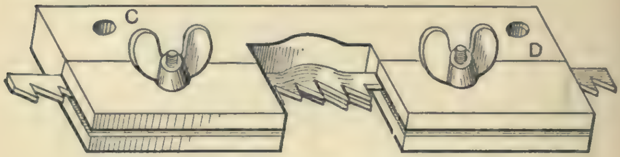


Fig. 60.—Band Saw Brazing Clamp.

powder, heat is applied by means of a torch, a blow pipe or by means of the brazing tongs shown by Fig. 61.

Tongs for the purpose of saw brazing consist of very large solid pieces of metal from 1 inch to 3 inches square hinged together like an ordinary pair of blacksmith's tongs but made to pinch closely and securely together against the entire length of the jaw.

The saw being in position as shown by Fig. 60, the brazing tongs, Fig. 61 are heated to a low red heat and then clamped carefully and firmly upon the ends of the band saw shown in the notch at Fig. 60. Pressure being applied to the handles of the tongs the jaws are brought together, the brass is quickly melted and the saw is pressed into close contact along the entire length of the lap. The tongs may be left in this position until the joint is cool

or they may be removed in a few seconds and the saw joint seized for a second or two with a common pair of pliers to make sure that the lapped ends remain in perfect contact during the cooling process.

Fig. 61.—Brazing Tongs.

When a blow pipe or torch is used for heating the saw a pair of cooling tongs is usually applied after the brass has commenced to run. The common form of cooling tongs is shown by Fig. 62 and, as may be seen by the

engraving, it is merely a pair of pliers with a very much elongated pair of jaws.

As soon as the brass is seen to run in the band saw bore the cooling tongs are gently slipped upon the joint

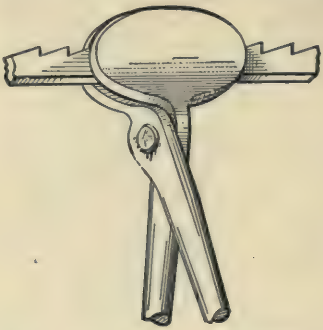


Fig. 62.—Cooling Tongs.

and pressed tight for a second or two, the source of heating being removed at the same instant the tongs are applied. The effect of the tongs is to squeeze the joint together and to hold it firmly during the cooling operation which is almost instantaneous, so quickly does the cooling tongs carry away heat from the saw.

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